SCIENCE.

FRIDAY, AUGUST 29, 1884.

COMMENT AND CRITICISM.

As we go to press the British association for the advancement of science is opening its first meeting on this side of the Atlantic. Although the acceptance of the urgent invitation to the British association by the Canadians was tardy, and at first reluctant, the English have responded at last with hearty good will; and the flood which entered Montreal on the early days of this week put the elasticity of the hotels, and the generosity of the people, of Montreal to the severest test. Though some of the scientific men, best known to fame and the American public through their former personal visits, or their writings of a general interest, — men like Tyndall and Huxley, Hooker and Lubbock, — have not come to the meeting, there are present on the opening day a sufficient number of the leaders of science to insure a notable gathering, and to well repay such of their American brethren as have taken long journeys to meet them. Many of our own countrymen are in attendance, glad to be among the first to welcome their colleagues; and many more would doubtless have come, did they not fear they would infringe too much on hospitalities intended for the honor of trans-atlantic friends. It is estimated that about eight hundred have crossed the Atlantic to attend the meeting, as members or associates, and that at least six hundred more have been enrolled from Canada and the United States, including the fellows of the American association who have accepted honorary membership.

The arrangements of the local committee have been as thorough and careful as could be expected. The rooms devoted to the use of the association leave, indeed, something to be desired, as many of them are far too small for convenience; but they have generally the advantage, not only of close proximity to each other, but of an airy situation on the upper edge of the city, which may be welcome before the week is out. But, in the halls of McGill college and its affiliated institutions, accommodation was not found for all; and the sections of geography and statistics have been assigned to rooms a quarter of a mile distant, in the city proper. The local committee has thoroughly canvassed the city, and printed a list of places where lodgings may be had. Each member is provided with a handbook of the Dominion of Canada, — a generous volume, accompanied by maps, containing all one could desire, excepting an index, and a plan of Montreal. The latter, however, is printed most conveniently on the back of the large, folding members' tickets. Evening *soirées* and garden-parties, with excursions in abundance, are planned at various times during the meeting; but the sessions are unbroken by any 'lunch,' except such as individuals may obtain at any time for a pittance, in a tent on the university grounds.

The sections meet daily at eleven, and continue in session for five hours without intermission. One sees the association here as he sees it in England, holding its traditions untarnished. In one matter, however, they have given way to Canadian solicitation by permitting the meeting of the association to be opened in American fashion, by addresses of welcome from the city of Montreal, holding a special session for the purpose. One point in which the association meetings differ notably from our own, is in limiting the attendance at all meetings, addresses, and lectures, as well as at all festivities, to members of one class or another. Such a restriction in our own association would doubtless be an additional incentive to membership in places where it holds its meetings and it could certainly prove no bar

to membership in other quarters. The meeting bids fair to be every thing its promoters could desire.

THE recent earthquake suggests two lines of unsatisfactory reflection. The number of appreciative observations of the shock, discoverable by careful search through many newspapers, is extremely small, although the movement of furniture, the swaying of suspended objects, and the overturning of chimneys, gave ample opportunity for critical examination. Records of time are also inaccurate in the highest degree. Seconds are rarely given, and there is no statement as to the error of the timepiece. In place of this, the temperature of the air, the direction of the wind, and the 'strange appearance of the sky,' are frequently mentioned, as if these irrelevant phenomena were of the highest importance. In a country where earthquakes are, happily, as rare as here, it would not be fair to expect that very many persons should take full advantage of their unlooked-for opportunity of earthquake study; but after making all due allowance for the infrequence of shocks, and for the small share of school instruction bearing on seismology, the general absence of critical observations is disappointing.

More remarkable than the earthquake, more surprising than the lack of observations, is the readiness with which some of those who ought to know better have committed themselves to explanations of the origin or cause of the shock, on the demand of the all-absorbing newspaper reporter. From one professor we learn that the shock "originated somewhere about the Rocky Mountains, and travelled eastward;" another was inclined to refer the disturbance to the "sliding of granite and trap strata, caused by contraction and expansion;" others still, hold to the gratuitous generalization that "every earthquake-shock is an uncompleted effort of nature to create a volcano." Such a variety of opinion fully justifies a reporter's rather sarcastic conclusion: "Thus the three professors differed from each other in their views." This difference is the more to be regretted, as there was excellent ground for agreement in answering the reporters. It would have been very safe to reply, "When we know what has really happened, we may be able to say something more about it."

THE necessity of irrigating extensive tracts of the west has taught us that irrigation has its advantages. The crops raised under it are not only larger, but more reliable, than those of districts where irrigation is not considered necessary. It is somewhat as though the farmer could control the amount and frequency of rainfall and it; shows, that, in countries where the rainfall is abundant, it is distributed in a manner that comes far short of the best. In some parts of the west there is water enough for irrigating purposes, but it flows in large rivers which it would require great expense to turn upon the land. The Upper Missouri and Yellowstone rivers belong to this class. They flow through arid but otherwise fertile districts. They are large and permanent streams, and it seems a calamity that they should be allowed to run forever to waste.

The suggestion of a contributor in another column, that the government take time by the forelock, forestall monopoly, and lead population into this section by establishing gigantic irrigating-works for the utilization of this valuable water, is not so wild as many of the schemes that actually have been put through Congress; as, for example, the Pacific railroad schemes. Is agriculture any less important than commerce? Yet it seems as though, in this chiefly agricultural country, it is the only interest that is unable to obtain a hearing. It has not even a cabinet officer to represent it. To judge from the space assigned to it at the Centennial exhibition, as compared with that devoted to war, for example, one would have supposed that war was the leading occupation of Americans, rather than agriculture. The question of irrigating the arid but irrigable portion of our public domain is destined to

become a leading one in the near future; and our statesmen will do well to begin soon to give it their thoughtful attention.

LETTERS TO THE EDITOR.

Increase in growth of young robins.

THE past season my attention had been attracted to the rapid growth made by a nest of young robins on our porch. Early in July another pair of robins built a nest on a bracket on the same porch, in which the female laid three eggs. I carefully watched the nest, to note the appearance of the young, as I had determined to accurately weigh the young birds daily, after hatching, as I was curious to learn just how much they might increase in growth during each succeeding twenty-four hours, up to the time of flight. On July 28, two eggs hatched, the third being infertile. At two o'clock, July 28, I weighed the young birds separately, as I did for the next twelve days at about the same hour. I have designated the birds as 1 and 2; and the following figures represent their increase in weight in grams: —

No.	July.			
	28.	29.	30.	31.
	Grams.	Grams.	Grams.	Grams.
1	5.8	8.7	14.3	21.15
2	6	10	14.7	24

No.	August.								
	1.	2.	3.	4.	5.	6.	7.	8.	9.
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
1 . . .	25	33.8	42.5	43.75	51.2	52.45	52.2	53	52.2
2 . . .	26.8	34	43.5	48	52.6	55.3	57.6	57.8	57.8

The above figures are surely interesting, and will, without doubt, surprise many readers who before had no idea of the increase in growth made by the young of birds. As can be seen, the growth made by No. 1 was not so constant and steady as that made by No. 2; and, whereas No. 1 lost some in weight Aug. 8 and 9, No. 2 sustained no loss. The loss in weight was owing, I think, to the great quantity of lice which infested the birds and nest. CHAS. S. PLUMB.

N.Y. experiment-station,
Geneva, N.Y.

The meng-leng.

In China the sphex, or solitary wasp, makes a neat mud-cell in a crevice, puts therein the store of young insects which are to be the food of its own larva, lays its egg in the midst, closes the entrance of the cell, leaving only a minute window in the front wall, and flies away, with reason for such complacency as is produced in the feminine mind by snug housekeeping. The egg develops, the larva sucks the juices of the imprisoned spiders and flies, and finally the little wasp issues through the window, equipped for flight in the sunshine.

The Chinese call this lone, busy, steel-blue insect the 'meng-leng,' and have a peculiar notion of its habits. They say that it has no domestic nor social relationships, but longs, like other creatures, for little folk of its kind. So it makes a cot, and puts therein the child of some fruitful mother of another family, seals the infant carefully into its domicile, and then, flying frequently back from commonplace occupations, it puts its mouth to the little window of the cot, and buzzes and sings 'meng-leng, meng-leng, meng-leng!' And the little creature within, hearing itself constantly called a 'meng-leng,' believes itself to be one, and gradually and surely verifies its name, coming out in due time a perfect sphex.

So in China an adopted child is popularly and poetically called a little 'meng-leng.'

ADELE M. FIELDE.

Indian languages in South America.

Your interesting notice of recent works on 'Indian languages of South America' (*Science*, Aug. 15, p. 138) requires to be completed by the mention of the remarkably valuable treatise by the venerable traveller, J. J. von Tschudi, — 'Organismus der Kechua sprache' (Leipzig, *F. A. Brockhaus*, 1884, 534 p.). For the first time in the history of American linguistics, we have here presented an exhaustive analysis of the lexical and grammatical structure of a native tongue, fully adequate to the demands of modern study. Von Tschudi has made a long investigation of the Kechua. As far back as 1853, he published his treatise upon it, and has twice edited the original text of the celebrated Ollantadrama (1853 and 1875).

The introduction to his last work occupies a hundred and twenty-five pages, and contains a brief exposition of his views on the ancient history and mythology of the Inca race, and on the affinities of their language. Based, as his opinions are, on a most careful analysis of the tongue and on ample personal observation, they must have great weight with future ethnologists and antiquaries. To mention only one of his many novel conclusions, he denies any affinity between the Aymara and Kechua languages, and considers Bertonio's grammar and dictionary of the former (from which such affinity has been argued) as based on a local and corrupt dialect.

I would further add to your list the meritorious treatise of Giovanni Pelleschi, 'Sulla lingua degli Indiani Mattacchi del Gran Ciacco' (Firenze, 1881), where, in the scope of seventy pages, he imparts much fresh information about this little-known tongue; and, if not too remote to be called recent, it is worth while mentioning the republication in Lima, in 1880, of the extremely scarce 'Arte de la lengua Yunga,' by F. de la Carrera, — an idiom presenting many curious features, both in phonetics and structure.

D. G. BRINTON, M.D.

Media, Penn., Aug. 16.

Fish-remains in the North-American Silurian rocks.

Mr. E. W. Claypole states in *Science*, July 11, that he has come into the possession of some fossil fish which lead him to the conclusion that there are forms of fish more ancient in America than are known elsewhere. From Mr. Claypole's letter, I gather that he imagines that the upper Ludlows and the 'bone-bed' are the earliest rocks which yield fish-remains. I would direct attention to the fact that the *lower Ludlow* rocks of England have yielded the remains of fish; viz., the Scaphaspis (Lankester). The Scaphaspis ludensis was discovered at Leintwardine, in *lower Ludlow* strata, which must have been deposited long ages before the accumulation of the upper Ludlow 'bone-bed.' Soon after the shield of this fish was detected, I personally investigated the physical position of the rocks in which it was found. The Leintwardine beds are the only locality where the

relics of this first-known fish have hitherto been found. Some excavations, made of late in the passage beds between the old red sandstone and the Ludlow rocks at Ledbury in Herefordshire, have afforded a fine series of the fish found in the 'bone-bed' and passage rocks. Among them, Mr. Piper has obtained plates and cephalic shields of Scaphaspis, Pteraspis, Cyathaspis, and Auchenaspis. Auchenaspis has been found perfect; and much more of the structure of these early fishes has come to light. But there is a good deal of difference in the geological horizon of these fish at Ledbury and that of the Scaphaspis at Leintwardine. The lower Ludlows appear in great thickness at Ledbury, but hitherto they have not presented us with fish. W. S. SYMONDS.

The Camp, Sunningdale, July 31.

Depth of the glacial submergence on the upper Mississippi.

I desire to call attention to certain facts which appear to me to indicate a submergence of even the highest land at this point, which, it may be said, is near the centre of the driftless area. I am not aware of their having been previously noted.

That which first called my attention to the matter was the discovery that the layer of broken stone which covers the undisturbed rock on the top of the bluffs to a depth of four to six feet, contained numerous shells belonging to several species of pulmoniferous gasteropods. I have thus far obtained specimens of the following species (the identifications were kindly furnished by Mr. Sanderson Smith of the U.S. fish-commission): Helicina acculeata Say, Lymneae columella Say, Helix (Patula) attenuata Say, Helix (Helicodiscus) lineata Say, Helix (Patula) striatella Anthony.

The condition of the shells, and the positions in which found, even more than the mere fact of their occurrrence, indicate submergence by giving strong evidence of wave-action, evidence of which is also seen in the general order and arrangement of the stones composing the layer, especially in the remarkable evenness of its upper surface. Overlying this layer of broken stone, and sharply distinguished from it, is a layer of earth from two to four feet thick, destitute of either stones or shells, and having all the characteristics of the loess, which, in unmistakable deposits, reaches a height of two to three hundred feet above the Mississippi. As the bluffs at this point reach to about five hundred feet above the river, a submergence to at least that extent is indicated, — a conclusion which is sustained by other facts, which I need not now refer to.

G. H. SQUIER.

Trempealeau, Wis.

THE VISIT OF THE BRITISH ASSOCIATION.

ALTHOUGH the British association does not meet officially on our own soil, we may yet regard it as in some sort paying a visit to our neighborhood, and opening up such an opportunity for personal communication between the scientific men of England and America as has never before offered itself. It is true that Principal Grant, as a Canadian by adoption, suggests to the members to be satisfied with Canada on this occasion, "and to leave the United States and Mexico to other and more convenient seasons." He strengthens this suggestion by the statement that the time of meeting of the American association was chosen so as to give the members of that body an opportunity of visiting Montreal, thus correcting the current impression that the object was to make it convenient for the members of the British association to visit Philadelphia. The Canadians may also feel fairly entitled to all the credit which the visit of the association can bring, since so long a journey by so large a body of men would hardly have been seriously considered, but for Canadian enterprise. A proposal was privately discussed among us, a few years ago, to invite the British association to Boston on the occasion of the anticipated exposition of 1883. But, after the exposition was abandoned, no one was so bold as to seriously press the invitation in the absence of any special attraction to second it; and it was left for our neighbors to successfully attack the problem which we had abandoned as hopeless. It is not, however, to be expected that the individual members of the association will be greatly influenced by sentiment in the use they make of their time on this side of the ocean, or that Canadian pride, enterprise, or loyalty, will prevent them from crossing the border. Not even such energy as that of our neighbors, and such glory as that of their dominion, can compensate for the charm of novelty in life and institutions offered the foreigner by such countries as "the United States and Mexico." It may be well worth the while of a studious Englishman to take a long journey to learn from actual inspection what an English province can become under the influence of so energetic a people as those of Canada; but he cannot suppress his curiosity to study the ampler and more varied civilization which his race is working out under political conditions less like those to which he is accustomed. We therefore look upon the present meeting as nearly the equivalent of a visit to our own country, and, in the name of the stu-

dents of science in America, we extend a cordial welcome to the greatest body representative of the intellect of the old world which has ever visited our shores. Did our visitors not represent the most hospitable of nations, we should indulge in bolder assurances of the warmth of the reception they will meet with from all classes of Americans. But those who know what English hospitality is will content themselves with modestly hoping that American hospitality does not fall far short of it, and with remarking that our great railways extend a corporate hospitality to distinguished visitors which is not known abroad.

The sentimental consideration that the visit is one the very possibility of which is a striking illustration of what science has done, will add zest to the occasion. In times past, the idea of a local society choosing a place of meeting across the Atlantic would have appeared as quixotic as can readily be imagined. Indeed, we can but suspect that the project at first presented a little of this appearance to a majority of those concerned, and that a meeting very successful in point of numbers was hardly expected. But the result seems likely to more than realize the hopes of the most sanguine supporters of the project, and it is fitting that the promoters of science should enjoy to the utmost a result which the work of their class has rendered possible.

Circumstances are in several ways favorable for paying us a visit. The time and place of holding the meeting of the American association were especially chosen so as to facilitate the reception of any visitors from the sister-organization who might grace the meeting by their presence. Arriving in Philadelphia, they will find not only our own association, but the electrical exhibition of the Franklin institute. Although the latter cannot be expected to rival the great displays at Paris and Vienna, it will afford a better opportunity than any which has been offered in Europe, for seeing what has been done here in forwarding the utilitarian applications of electricity. Visiting electricians, of whom we may hope for a considerable number, may also expect an invitation to take part in the electrical conference, which is to be conducted under the auspices of the government, and in which the novelties of the exhibition will be made known. Philadelphia is only four hours distant from the national capital, and thus a visit can be made to the collections of the government without any serious loss of time. The division of his time between pleasure and business will be a question for the decision of each individual visitor, to whom the journeys and excursions tendered to the American association will be freely open. He should, however, bear in mind that the colleges and universities are generally in vacation till near the close of September.

Finally, the student of politics and sociology will regard it as fortunate that his visit takes place in the height of a presidential canvass, thus enabling him to study one of the most interesting of political phenomena on the largest scale. If he judges only from the course of newspaper criticism on the presidential parties and candidates, he will doubt what the future has in store for us; but, if he looks deeper, he will see a process of endosmosis, by which, from the huge mass of objurgation, falsehood, and not very elevated humor, political acumen is being infiltrated into the minds of millions of voters. And no one, whatever his politics, need fear the danger of being converted to new principles. Whether he be the most advanced Liberal, or the most conservative Tory, he will have no difficulty in seeing every thing by the light he brings with him, and returning home with all his views strongly confirmed.

LORD RAYLEIGH.

LORD RAYLEIGH, the president of the British association of science for this year, is well known to all Americans who have kept pace with the development of physical science. Although his reputation cannot be called a popular one, yet no student of physical science can well be ignorant of his investigations; and his treatise on sound places him easily in the front rank of writers on a subject of which the

theoretical and practical importance is second to none in its bearing on the progress of humanity.

John W. Strutt, the third of his race bearing the title Lord Rayleigh, is the eldest son of John James, second Lord Rayleigh, and of Clara Elizabeth Latouche, daughter of the late Capt. Vicars, R.E. He was born Nov. 12, 1842; was educated at Trinity, Cambridge, of which he was a fellow. He was married in 1871 to Evelyn Georgiana Mary, second daughter of the late James Balfour, Esq., of Whittinghame, N.B., and succeeded to the title in 1873.

Lord Rayleigh's career at the University of Cambridge, which he entered at the age of nineteen, was a distinguished one. He secured the Sheepshanks astronomical exhibition in 1864. The following year he came out senior wrangler and first Smith prizeman. Trinity college thereupon elected him to a fellowship, which he held until his marriage, in 1871. In 1879 he was elected to succeed Maxwell as director of the Cavendish physical laboratory at Cambridge; and he received the medal of the Royal society in 1882, and was president of section A of the British association in 1882. This brief record of the important dates in the life of Lord Rayleigh may make his life seem uneventful to the ordinary reader; but the student of his writings will perceive that the years between his acceptance of the fellowship at Cambridge, and his appearance as president of the British association for the advancement of science at Montreal, have been eventful in the scientific sense, and full of work. It was no ordinary compliment to a man to be selected as the successor of Maxwell. We well remember the commendation pronounced by leading English men of science before Lord Rayleigh became director of the Cavendish laboratory, — 'strong man, Lord Rayleigh;' and this simple and peculiarly English method of commendation still expresses the truth to-day. An Englishman said to the writer lately, "They question the necessity of the House of lords and the use of lords. Look at Lord Rayleigh! Cannot we expect from this select body of men of hereditary traits and of inherited possessions great things in science, if they will only abandon the subject of franchise bills and the marriage of wife's sisters, and follow the path pointed out by Lord Rayleigh?"

Lord Brougham, it is true, had scientific tastes, and wrote papers on optics; but, if one wishes to compare the physical science of Brougham's time with that of the present, and, moreover, to compare the scientific attainment of Lord Brougham with Lord Rayleigh, let him read Brougham's papers, and then turn to Lord Rayleigh's investigations on diffraction-gratings, and to his various papers on theoretical optics. Perhaps his most important work is the 'Theory of sound,' in two volumes, begun on the Nile in 1872, and published in 1877–78. This work has received the commendation of Helmholtz, and takes the place, in theoretical acoustics, which Helmholtz's 'Tonempfindungen' fills in physiological and practical acoustics.

In looking at Lord Rayleigh's investigations before the appearance of the 'Theory of sound,' we perceive that he has embodied in this work the special investigations and mathematical work of nearly ten years. Before the appearance of this work, the subject of acoustics had been treated in a disconnected manner. There were geometrical, and what might be called synthetic, treatises; but, with the exception of Donkins's 'Acoustics,' there was no generalized and analytical work on sound. What Newton did for mathematics, when he discovered the method of fluxions, or the principles of the differential and integral calculus, Lord Rayleigh has done for sound. He has bridged over, so to speak, angular intervals, has filled up discontinuities, and has made the general treatment of acoustical equations flexible. In reading this treatise, one speedily finds that it is not a narrow or limited one. The entire range of modern mathematics is employed; and the system of generalized co-ordinates receives, in this treatise, perhaps the greatest exemplification of its power. One cannot read the treatise who has not become familiar with

the highest flights of modern mathematics. Moreover, the lecturer on the great doctrine of the conservation of energy will find that this book is founded upon this doctrine, and opens with its fundamental equations. Lord Rayleigh pointed out, before the appearance of this treatise, the use of a peculiar function, expressing the law of decay, so to speak, and subsidence of impulses in any system or configuration; and although he probably saw its chief employment was in the discussion of the dissipation, and frittering into heat, of sound-vibrations in any complicated system, yet he probably saw, in common with Maxwell, that the dissipation function could be employed in electricity to express the oscillation and change of electrical induction-currents, also, into other forms of energy. The intelligent reader of Rayleigh's 'Theory of sound' has a great intellectual pleasure in tracing in it the methods of reciprocity of similitudes, the illustrations of the conservation of energy, and must rise from its perusal with a clearer notion than he has had before of the unity of physical forces, of the great modern truth of the equivalence between work and heat.

Since Lord Rayleigh has become director of the Cavendish laboratory, he has organized its scientific work, and has made it a centre of physical investigation as well as of instruction. His determinations of the ohm, which were presented to the Paris conference of electricians, 1883–84, were generally regarded as the most accurate, and formed the basis of the unit of electrical resistance now formally adopted. He has lately investigated the methods of obtaining a practical unit of the strength of an electrical current, and has shown that the method by the deposition of silver is capable of a high degree of accuracy. It will be seen that he unites unusual qualities for director of physical science, great mathematical ability, and the power to execute and supervise scientific investigation.

Lord Rayleigh's countenance will soon become familiar to every American man of science; and we hope that even the uneducated American will learn to see in him, not the lord of the manor of Terling and the patron of two livings, but a peer of the distinguished school of mathematicians of Cambridge, Eng., the pre-eminence of which, in mathematical science, American centres of learning can honor, but not dispute.

ATMOSPHERIC ELECTRICITY.

At the present time there is no satisfactory theory of the source of atmospheric electricity. Many believe, in the absence of positive evidence of the production of electricity by the operation of evaporation and condensation, that the earth has a definite charge, which resulted from the operations at its birth, and which it has kept undiminished in amount; and that thunder-storms are merely the expression of local accumulation due to currents of air.

Mr. G. Le Goarant de Tromelin, in a late number of the *Comptes rendus*, advances the opinion that atmospheric electricity is due to the friction of the air, humid or dry, upon the surface of land or water, and calls attention to Armstrong's hydro-electric machine, which produced electricity of high tension by the friction of jets of steam in issuing from narrow orifices. According to Tromelin, the wind, in skimming over the surface of water, carries water from the crests of the waves, which play the part of the comb of Armstrong's machine. The roughness of the soil does the same on land when a damp wind passes over it. The charge thus produced is collected upon the vesicles of clouds. The potential energy of a cloud depends upon its configuration and its temperature. If this configuration changes under the effect of condensation or congelation of the aqueous particles, the cloud absorbs a certain amount of energy, which must be found again under the form of an augmentation of potential energy: hence there is an electrical interchange constantly going on in the cloud region of the air; and when these changes are rapid, and great in amount, we have thunder-storms and other great electrical manifestations.

The advocates of Mr. Tromelin's views can point to the effect of the blasts of sand driven by the wind upon the pyramids, and to the extraordinary electrical manifestations upon high peaks in Colorado, where every *aiguille* seems to hiss, at times, with the escaping electrical charge.

We believe that the time has arrived when the scientific world no longer looks upon electrical phenomena as isolated and separate from the phenomena of heat and light, or chemical reactions. We cannot believe that any change can take place in the arrangement and mutual attractions of molecules without electrical manifestations. If we are to have a thermal chemistry, we must also have an electrical chemistry; and the history of the energy of a chemical reaction is not completely told when we sum up the heat of this reaction, unless we count also the heat-equivalent of the resulting electrical changes. If we were, therefore, to frame a theory of atmospheric electricity, we should begin it with the assertion that every change in the configuration or arrangement of particles of matter is accompanied by an electrical disturbance; and, as far as this assertion goes, all the present theories of atmospheric electricity would fall under it as special cases.

The object of this paper, however, is not to frame hypotheses, but to trace the recent work which has been done in systematic observation of atmospheric electricity. It is only to systematic observation that we can evidently look for information which will be of immediate practical value to our signal-service. Unfortunately, no systematic observations have been made for any length of time in any country.

The electrical conference at Paris, held last April, was adjourned from a meeting of the previous year; and committees were appointed to study the subject of atmospheric electricity and earth-currents in different countries. The time was evidently too short for such a stupendous undertaking; but the conference did valuable work in stimulating systematic observation, and creating a bureau at Berne, to which it was recommended that observations made in different countries should be sent. The agitation of the subject of such observations called forth several papers. Professor Ròiti of Florence presented to the conference the result of observations made through several months with a self-registering apparatus. He found that the zero of Mascart's electrometer changed from time to time, and traced this change to the mechanical effect of the sulphuric acid upon the platinum wire connected with the electrometer needle. He therefore dispensed with the Leyden jar of the Thomson and the Mascart electrometer, and suspended the needle by a very fine silver wire which was connected directly to the positive pole of a water-battery of many cells. This instrument was found to work well. Professor Ròiti believes that local disturbances have great effect, and that these local effects must be carefully taken into account in comparing simultaneous observations over large areas.

Athough the scientific world has generally accepted Thomson's quadrant electrometer, or some modification of it (like that of Mascart's or Clifton's), as the most suitable instrument for the observation of atmospheric electricity,

and has also adopted Thomson's water-dropper (which consists merely of an insulated can of water connected with the quadrants of the electrometer, the water issuing from this can in small drops, reducing it to the potential of the air), still there are those who believe that this method does not give correct results. Professor Palmieri, who has been connected so long with the meteorological stations on Mount Vesuvius, rejects Thomson's electrometer, and the water-dropper also. He believes that the electricity of the air is not led to the water-dropper by conduction, and that the insulated water-can does not take the electricity of the air by any similar process. According to his views, the electrical state of the air can be ascertained by its inductive effect upon a disk of metal which is suddenly elevated or lowered in the air; and he has devised a special electrometer, strongly resembling Peltier's electrometer, and a special apparatus for elevating and lowering a disk. He, moreover, does not think that continuous photographic registrations are of much use, since electrical observations are only of value when accompanied by observations on the condition of the sky with respect to clouds, and upon the direction of the wind.

Professor Palmieri's methods and instruments do not impress us very favorably. There must be great difficulty in insuring good insulation by his method of suddenly elevating a disk in the air. Moreover, his theory of induction does not appear to us to be well founded. The Thomson method of observing atmospheric electricity seems to promise better results than any other; yet it is not by any means perfect, especially in its practical adaptation to the needs of a government signal-service. The experiments which are being conducted at the physical laboratory of Harvard college show that in the American climate it is extremely difficult to secure a regular flow of water from the water-dropper, and to obtain good insulation, on account of frost and snow. During the months which are free from snow and ice, heavy showers wet the insulating stand of the water-dropper, and thus destroy the insulation. The latter evil can be obviated to some degree by a well-constructed screen of wood. It has been found preferable to neglect the insulation of the can, and allow the drops of water to fall upon a metallic plate, thrust out from the side of the room in which the electrometer is situated, by means of a glass cylinder through the centre of which runs a wire which connects the metallic plate with the electrometer. The drops of water fall, in turn, from the metallic plate, and reduce this to the potential of the air, while the insulation of the metallic disk can be perfectly maintained in all weathers. Preliminary experiments have also been made upon an arrangement which promises to be of use in winter, when the weather would prevent the use of the water-dropper. This arrangement consists merely of a wheel provided with metallic brushes. The wheel is run rapidly by simple clock-work, and is insulated. The brushes touch one end of an insulated conductor exposed to the air, and then touch a conductor connected with the earth, in this way imitating the action of the water-dropper. An arrangement of this kind, which will work in all changes of weather, is essential in the climate of the United States.

The preliminary experiments at the laboratory of Harvard college have also shown that it is essential that the electrometer should not be very distant from the water-dropper or its equivalent. A naked iron wire connected the electrometer with a water-dropper which was about three hundred feet distant at the top of a building, and at least sixty feet from the ground. The photographic record of the excursions of the electrometer needle showed that it moved irregularly to and fro under the influence of the fluctuation of potential along the wire. There is evidently a certain relation between the size of the conductor, which is reduced to the potential of the air by the succession of water-drops, and the number of orifices from which the water must issue in order to reduce the conductor and connecting wire to the potential of the air.

The photographic records that have been made show unmistakably that north-west winds in the colder months are preceded by a rise in the electrical potential of the air, and that during an east wind the potential falls. These general indications seem to be independent of local effects, and lead us to believe that electrical signal-station observations will be useful in predicting changes of weather. Photographs of the varying electrical state of the air could be forwarded to Washington from different stations, and a map could be made on which stations at the same electrical potential could be connected; and thus any law connecting the electrical state of the atmosphere with other meteorological changes could probably be ascertained. Much remains to be done, however, in ascertaining the best position for such signal-stations, and in perfecting simple and practical apparatus for the use of comparatively unskilled observers.

JOHN TROWBRIDGE.

IRRIGATION IN THE UPPER MISSOURI AND YELLOWSTONE VALLEYS.

In crossing the great plains over the Union Pacific railroad, through Nebraska and Wyoming, or over the Kansas division through Kansas and Colorado, one is struck not only by the aridity of the country, but also by the fact that no streams of water exist there, adequate, if completely utilized, to irrigate any considerable part of that immense area. One is also struck by the monotony of the physical features, the absence of mountains or hilly areas, as well as of timber. The possibility of settling this vast region seems very remote; and only the discovery of some new and as yet untried method can prevent these plains from constituting, for ages to come, the great natural barrier between the east and the west, — a barrier far more complete than that furnished by the Rocky Mountains themselves.

This condition exists to a greater or less extent as we go southward, though the direction of this belt of uninhabitable country lies somewhat to the west of south. Before I had seen Dakota or Montana, I feared, when reflecting upon these facts, that such a belt might extend northward also, and thus, as it were, actually divide the United States into two sections, marked off from each other by a permanent physical obstruction. This problem seemed to me of the utmost importance, for it is the remote future that must be considered; and if the country has proved capable of so nearly dividing upon an east-and-west line, where there does not exist a single natural feature to render the two sections distinct, what might not be apprehended at some future day, when sectional differences arise between the east and the west, if cut off from each other by an uninhabited desert five hundred miles in width?

It was therefore with special interest that I studied the northern extension of this belt. The fact that the isohyetals actually curve eastward, i.e., that the precipitation is less as we go northward on a given meridian, led me to suppose that the difficulties would not diminish. It is certain, however, that the decreased evaporation, due to the reduced temperatures of the more northern parts of the dry belt, much more than compensate for the difference of rainfall. It is, moreover, currently believed by the inhabitants of these more northern districts, that the atmosphere is constantly kept somewhat moist by the influence of the Pacific coast and the Upper Columbia region. A short sojourn on the Upper Missouri and Yellowstone Rivers convinced me of the accuracy of this view. The general movement of the atmosphere is from west to east. The mountains to the westward are not high, — at least, except at isolated points, — and do not, therefore, suffice to condense all the moisture that passes over them. Near the sources of these streams, as at Bozeman, crops are raised without irrigation, whenever they can withstand the frosts, although the rainfall is there only sixteen inches per annum; and the same is true for eastern Dakota, with no greater precipitation. It is also a matter of record, that the temperature on this latitude diminishes toward the east, and that colder weather prevails in Minnesota than in Dakota, and in Dakota than in Montana. The people attribute this to the occurrence of what they denominate 'Chinook winds;' i.e., winds laden with moisture, and moderated in temperature from the warmer regions of the Pacific slope.

Notwithstanding this, it must still be confessed, that, for all the lower parts of this region of country, — the proper valleys of these rivers, — irrigation is essential to successful agriculture. All statements to the contrary are inspired by interest, usually by the railroad interest, which hopes thereby to increase travel. A number of instances of this came to my notice, one in particular, in which a resident who had published such a statement in a railroad circular was found reaping a field of unfilled oats, six inches high, to be stacked for fodder.

Is this country, then, inhabitable, i.e., capable of sustaining a population? No one will deny that it now possesses advantages for stock-raising; but a country which is only fit for flocks and herds can never have sufficient population to give it importance in a state. A mining region may attract enough inhabitants to become somewhat influential, and will remain so as long as the mines continue to yield. But the only permanent and reliable basis of population is agriculture. It is not necessary, however, that all the land be devoted to agriculture: in fact, it really needs that only a small portion of the soil be actually under the plough to support comfortably a region in which other operations can be carried on in parts not adapted to agriculture. If that portion of the Upper Missouri and Yellowstone valleys which lies between the river and the first general rise or terrace, including the valleys of the numerous *coulées*, or creeks, that flow into it as far as the same level would extend, could be adequately irrigated, this area would furnish an agricultural basis, sufficient, with the great stock-raising region that lies back of it, to

guarantee the ultimate settlement of the country to any required degree of density. I speak of the valleys of these rivers, because it is along these that railroads are either already constructed, or are soon to be constructed; and also, because, whatever may be the case elsewhere, a large part of these valleys far above the flood-line is alluvial in character, and highly fertile.

Now, in comparing this region once more with that of the Upper Platte, whether with the south fork in Colorado, or with the north fork in Wyoming, one great distinguishing fact of the utmost importance presents itself. This fact is, that while, if every drop of the water that flows in the Platte and its tributaries could be turned upon the land, it would only irrigate a small fraction of its own valley, we have in the Missouri and Yellowstone, even in August, a volume of water large enough, if economically applied to this object, to convert the whole of the arable land lying adjacent to them into a rich agricultural region.

Major Powell and his able assistants have carefully calculated the relation of water-supply to irrigable territory; and they come to the conclusion that in Utah a flow of one cubic foot per second will irrigate one hundred acres of land. If this should prove a low estimate for Utah, where evaporation is so rapid that it dries up large rivers almost in their course, it would certainly be ample in the region of Chinook winds.

The volume of water carried by the Upper Missouri and Yellowstone for that part of their course of which we are speaking has not been definitely ascertained. The average annual discharge of the Missouri River at its mouth was determined by Humphreys and Abbott at 120,000 cubic feet per second. A measurement was once taken at the source of the Upper Missouri, i.e., at Three Forks, at a time when the river was found to be four feet below high water, and eight inches above low water, when the volume was found to be 8,541 cubic feet per second. Between these two great extremes we are compelled to estimate for our present purposes. Perhaps 50,000 cubic feet per second would not be an excessive estimate for the volume of the Missouri below the mouth of the Yellowstone; or, assuming, as is claimed, an equal volume for each branch, 25,000 feet each for the two rivers above their junction. The calculation should not be based upon low water, since little use can be made of water in August and September, when the rivers are lowest; while it is in May and June, when the water is still high, that irrigation is chiefly required.

Each of these rivers, could all their water be utilized, would irrigate, at the above estimate, 2,500,000 acres, or nearly 4,000 square miles. This average would hold for points higher up; since the supply of these streams from their tributaries scarcely exceeds the evaporation, and the Missouri is not much larger at Fort Union than at Fort Benton. The distance between these points, by the windings of the river, is 669 miles. If the valley of this river could be irrigated to a width, on an average, of two miles, this would make, at the most, less than 1,400 square miles of surface. This, however, would be reduced in many ways. The smaller curves would be straightened. Much of the way the valley is narrow, and for long stretches, especially in the upper portion, it is reduced to a mere cañon: 1,000 square miles, or 640,000 acres, would be a large estimate for this portion of the Upper Missouri, which certainly would not require more than half of the available water. The same would be true of the Yellowstone; and thus, after thoroughly irrigating their own valleys, these great rivers might, should this be found practicable, furnish large quantities of water, to be conducted from points near their elevated sources to other outlying fertile tracts, which would also become the centres of a wide-spread and thrifty population.

To this scheme, I am aware, many minor objections may be raised, such as the destruction of navigation, about which there would be differences of opinion, but especially respecting the method by which it could be put into practice. This latter question, neglecting all details, we may now briefly consider in its most general aspects.

It is in the nature of things, that the settlers themselves of the districts in question can never carry out this extensive system of irrigation. To be made a practical success, it would require an immense outlay of capital. The few who will go there, knowing that no such system exists, could never afford to inaugurate it. The effect of its not being done must be to prevent its ever being done: therefore, under the ordinary laws of supply and demand, it can never be accomplished; yet no one in this age of great engineering enterprises will deny the physical possibility of such a scheme. Scarcely any one, probably, could be found to question its importance. It must be clear to all, that, if the means of readily irrigating these lands existed, that country would be rapidly filled up by a thriving agricultural population, which would bring after it its customary train of civilizing agencies.

And the political-economist knows that this means increase of national wealth, while the statesman sees in it enhanced national stability and power. Yet, by the natural method on which civilization advances, the conditions to this much-needed settlement can never be secured.

Notwithstanding this, I believe this end will yet be reached. The human race is rapidly outgrowing the natural or genetic method. There is another method, scarcely as yet recognized by the political-economists, but which is being more and more resorted to by enlightened men for overcoming such great physical obstacles to the attainment of clearly-perceived advantages. This is the method of foresight, or calculation. Individuals employ it for the attainment of both private and public ends. Capitalists combine, and lead civilization into regions it would otherwise never have penetrated. It is very probable that a gigantic irrigating company will some time be formed, which will, by degrees, accomplish more or less satisfactorily the desired object. But, in such case, great evils are likely to result, — evils analogous to those that have arisen from permitting great corporations to construct much-needed transcontinental lines of railway. An immense irrigation monopoly would inevitably grow up, which would largely neutralize the benefits derived from the project. Settlement would be impeded by excessive water-rates; and endless litigation, and conflicting legal decisions, would constantly deter population, and jeopardize industry.

A far better plan would undoubtedly be state action. If the territory of Montana possessed the means to undertake such a scheme, it could scarcely fail to prove highly remunerative at the end of a certain period. But here some such an obstacle exists as in the case of mere spontaneous settlement. Not until these tracts are already well-peopled will the territory possess the means of inducing settlement; and we have again a 'vicious circle,' which ends where it begins.

The only unobjectionable plan, as it seems to me, is *national* action. The nation is the largest of all capitalists, and, at the same time, has no tendencies towards monopoly. If we could obtain the same degree of collective foresight in the general government as exists in the average capitalist, nothing could be easier than for the United States, acting as a corporation that seeks only its own interest, not only to secure the particular end of which we are now speaking, but to develop its own resources, and increase its wealth and prosperity in numberless other directions, by the ordinary exercise of such foresight.

The present case seems to be one in which the nation has a special interest, rendering it peculiarly fitting that it should extend its aid. It is of the utmost importance as a matter of *national* security, and of immunity from dangers which no statesman can foresee, that the rapidly-growing west, with its peculiar interests, be cemented as speedily and firmly as possible to the east; and nothing can so effectually secure this end as to make the population of the entire Union an unbroken phalanx from the Atlantic to the Pacific.

Lester F. Ward.

LAWSUITS AGAINST GRUBS AND GRASSHOPPERS.

Everybody knows that migrations of grasshoppers were a hard plague in biblical times, and even before them. Ever since those remote centuries this plague has not ceased to disturb mankind, accompanied or followed by failure of crops, by famine and pestilence. Wherever these hideous guests arrived, the most persistent war has been waged against them, but it has always ended with the defeat of mankind. The consequences were the same as in all other defeats in those remote times. When men were helpless, the intervention of the law or the intervention of God was called upon to interfere, and to stop the ravaging intruders. The reasoning of the people was indeed rational, considering the low state of culture and education. The officers and representatives of the law, as well as the clergy, the natural interpreters between the people and God, were obliged to submit to the wishes of the helpless and therefore unruly people. It is to be supposed that both acted in good faith; nevertheless, we find sometimes indications of a more advanced intelligence, and it is evident that they have then submitted only because resistance was impossible. As such proceedings would have been too ridiculous and useless if not done in a seemingly lawful and imposing form, we find that by and by the development of laws against obnoxious creatures in the middle ages was perfected. A defender was given to the miscreant, as it was deemed lawful that he could not be judged and condemned without being heard and defended. According to the opinion of the old jurists, even to the devil a defender cannot be denied: therefore we find a number of curious law cases reported in those times. In the south of France, a pig which had killed a child was condemned and hanged. Some thieves were hanged, together with their dogs; and the Lex Carolina contains a number of paragraphs, not very fit to be repeated, which imposed the sentence of death on animals. Lawsuits against creatures obnoxious to men, and injuring their property, are often reported by the chroniclers, sometimes with a certain kind of

humor. Grasshoppers and grubs were the most frequent offenders.

Bartholomaeus Chassanaeus, a jurist of repute in the old territory of Burgundy, proposed a course of proceedings proper for such a lawsuit, and its consequences, — the judgment of excommunication. He says, after written summonses are served, and after a judge is appointed, two advocates are to be chosen, — one for the people, the other for the grasshoppers. The first begins the case against the defendant, and concludes finally that the grasshoppers should be burnt. The other advocate objects, and answers that the order cannot be issued until after a judgment has been rendered that the grasshoppers should leave the country. If this was not done by the defendant in a specified term of days, the thunder of excommunication was to be thrown on the defendant.

A later jurist, Job Ludolf of Saxony, a man with the extraordinary knowledge of twenty-five languages, speaks in 1694 at some length against the proceedings just related. He declares himself to be pained by the lack of knowledge of the law of excommunication shown by Bartholomaeus, and by the miserable arrangement of the process as proposed by him. Apparently it was at that time not the fashion of to-day among lawyers to begin with the slur of "a slight difference of opinion, as emitted by my honored friend on the other side." Ludolf says, when the greater excommunication is intended, the defendant has to be summoned before the court in the prescribed manner the first, the second, the third, and the fourth time, and then has to be brought before the court. Then comes the answer of the defendant. The argument and the principle of law must be given, so that it may appear whether the controversy consists in a difference about facts or law. It must be decided whether witnesses are needed, and on whom the burden of proof falls. Other parties interested in the case ought to be thought of: for instance, tame and wild birds should be heard, because they are in danger of being deprived instantaneously of their favorite food; the Acridophagi (grasshopper-eating people) should be heard, as they could otherwise take exceptions, and move the nullity of the case, or they could by appeal from the judgment, which injures other parties and is therefore unjust, suspend the execution of said judgment. Further, it would be unjust to compel grasshoppers to leave and to go to neighboring territories; and perhaps it would be more to the point to allow them to be eaten by any one who likes them. The proceeding proposed by Bartholomaeus, says Ludolf, could never be proved to agree with the decree of the Holy See; and nothing like it is to be found in the Pontificale Romanum. There is a threefold excommunication, — the minor, the major, and the anathema (which is the end of all), — "that the culprit's body is given over to Satan, to save the spirit for the day of the last judgment." After all, it seems that lawsuits in those days have been very similar to those of to-day, — not shorter, not less complicated, except that nothing is mentioned about retainers and obligatory fees.

It is only right to state that Ludolf concludes with the following words: 'But of what use is all this against disgusting beasts?' It is praiseworthy, that, among the twenty-five languages known by him, he chose just the one known by everybody to express feelings which could easily have been followed by more than dangerous consequences in those dark times.

In 1479 appeared in the canton of Berne, Switzerland, an enormous number of grubs; and it was feared that the whole crop would be destroyed: therefore the council of the commonwealth sent a deputation to the Archbishop of Lausanne, with the petition to banish the obnoxious creatures from the canton. Of course, it is not stated that the neighboring cantons had agreed to receive the grubs, but the archbishop seems not to have considered the incongruity of said petition. He gave an affirmative answer, and authorized the priest at Berne to impose the banishment of the grubs, providing for strict observance of the customs and laws. After a prayer, an advocate for the people was chosen. He notified the court of his appointment, and proposed the citation of the grubs. On a certain day some of the grubs were brought before the court, and their advocate chosen. The priest, followed by a large crowd of pious people in a solemn procession, went to the cemetery, to the fields, to the vineyards, and to the banks of the river, to serve the summons on the defendant. He delivered the following, at that time probably courteous, address as warning and as citation to the felons: —

"Ye hideous and degraded creatures, ye grubs! There was nothing like ye in the ark of Noah. By orders of my august superior, the archbishop of Lausanne, and in obedience to the holy church, I command ye all and every one to disappear, during the next six days, from every place where food grows for man or beast. If not obedient, I enjoin ye to appear on the sixth day, at one o'clock, afternoon, at Willisburg, before the Archbishop of Lausanne."

As some righteous people objected because the citation was not exactly made in the manner provided by law, the case was postponed, and, after a lawful citation, another day was named. Then the process began. The advocate chosen for the defendant was Jean Perrodet, a well-known dogmatical and obstinate disputant. Perhaps it will appear somewhat doubtful if the nomination of this advocate fulfilled exactly the demands of the law and custom of the time, as it is stated that Mr. Perrodet died a short time before his nomination. Nevertheless, the case and the complaint were read; and, as no defender appeared, the judgment was given for the plaintiff.

"We, Benedictus of Monferrand, Archbishop of Lausanne, condemn and excommunicate Ye obnoxious worms and grubs, that nothing shall be left of Ye, except such parts as can be useful to man."

The government ordered its officers to report the consequences of the excommunication; but the saucy chronicler says "that no success had been obtained — probably on account of the sins of the people." In the year 1338 immense swarms of grasshoppers came from Tartary to Hungary and Austria, and arrived the day of St. Bartholomew at Bozen, South

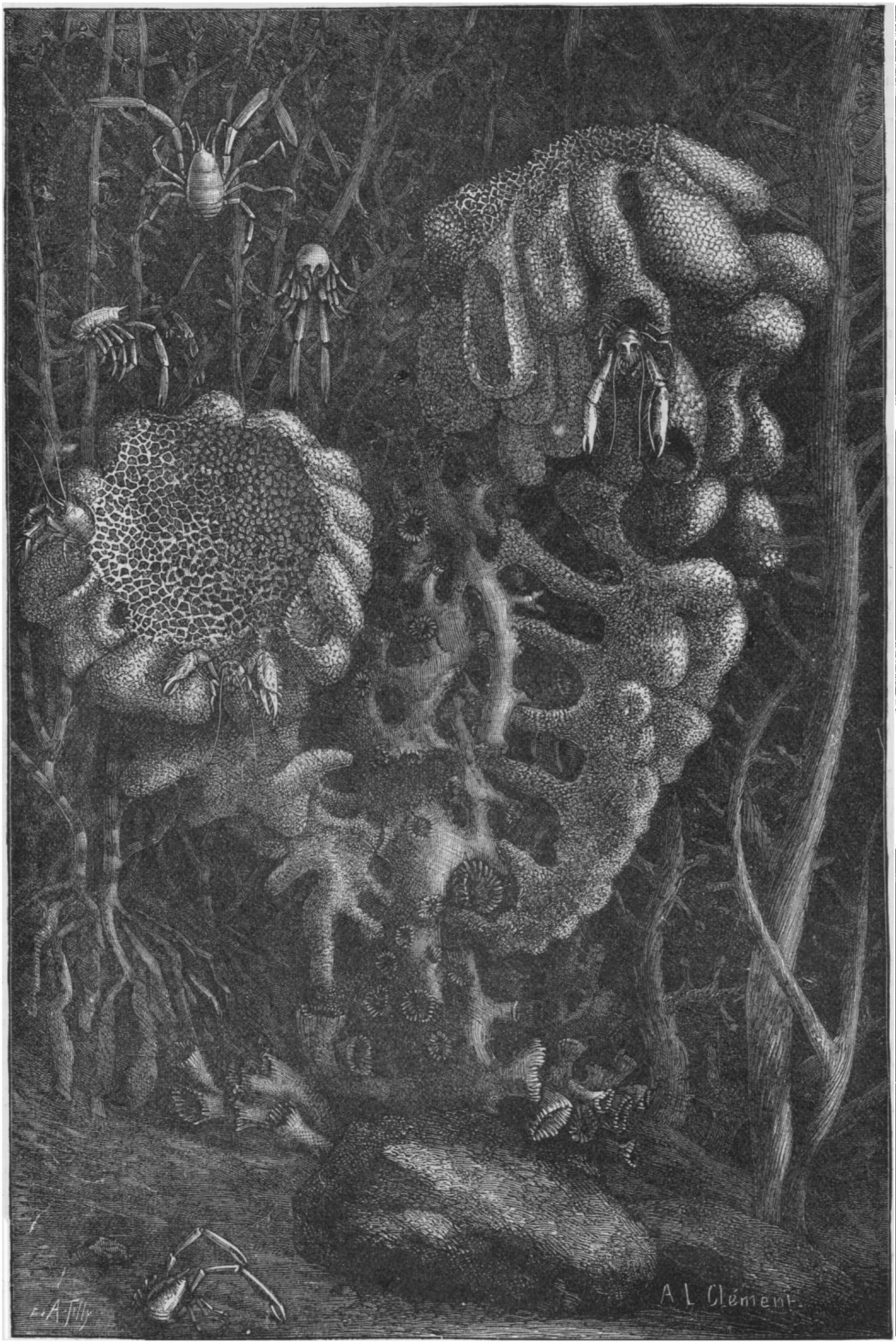


FIG. 1.—BOTTOM OF THE SEA AT A DEPTH OF TWELVE HUNDRED METRES, PEOPLED WITH COELENTERATES (MOPSEA), IN THE BRANCHES OF WHICH CRABS (GALATHEA) CRAWL ABOUT, AND BY SILICEOUS SPONGES ATTACHED TO CORALS (APHROCALLISTES), OR ANCHORED IN A VASE (CHONDROCLADIA).

Tyrol. The migration lasted seventeen days, from morning till night. The grasshoppers came down and ate every thing, grape-vines excepted. The swarms were so thick that the sun could not be seen, and they went farther to the shores of the Mediterranean. But the eggs and the young ones hatched from them were left behind: therefore a process was begun against them. The grasshoppers were condemned and excommunicated by the priest of Kaltern. The judgment was framed as follows: —

"As grasshoppers are obnoxious to the country and to men, be it resolved by the court that the priest shall, by candles burning from the pulpit, condemn them in the name of God, of his Son, and of the Holy Ghost."

A similar process was begun in the year 1516 against caterpillars in Troyes, France.

H. A. HAGEN.

THE LOWER FORMS OF LIFE DREDGED BY THE TALISMAN.[1]

ACTINIAS, generally known as sea-anemones, attract attention both by the beauty of their forms and by their bright and varied colors. They are represented in the deepest waters, and some forms gathered on bottoms at from four thousand to five thousand metres possess a color as beautiful as that of the shore species.

Madrepores have a carbonate-of-lime skeleton. They are present sometimes in abundance to a depth of twenty-five hundred metres. Madrepore branchus generally covers large districts, and often the cords of trawls dragging on bottoms inhabited by Lophelia were torn in shreds. Solitary madrepores are very numerous, and especially affect muddy bottoms; and they have beautifully varied forms, some resembling a cup, others a horn, and still others having the form of flowers.

Various forms of alcyonarians, a special group of corals, were found at considerable depths. At the Cape Verde Islands the same species of coral which is found in the Mediterranean, and is of so great commercial value, was found at a depth of a hundred metres. Between five hundred and six hundred metres there was found an interesting alcyonarian, Coralliopsis Perieri, which much resembled Dana's Corallium secundum of the Fiji Islands. Isis and Mopseas (see fig. 1), with slender rods formed of a series of calcareous cylinders supporting flower-like polyps with eight bi-pinnated tentacles, were taken at twenty-five hundred metres. Other forms, with gorgons, having a horny axis with metallic reflections like gold, people with their graceful forms the abysses of the ocean.

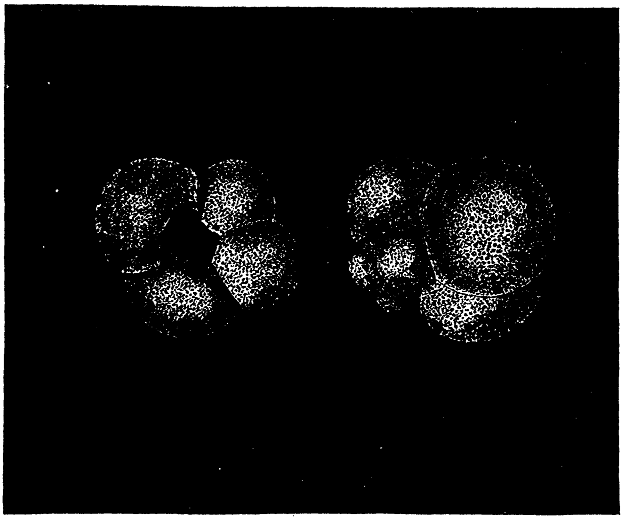


FIG. 2. — GLOBIGERINA AND ORBULINA, MUCH ENLARGED. (From *Science et nature.*)

The sponges form one of the most interesting parts of the Talisman collection. One generally thinks of these as always possessing the characteristics of our commercial sponges. When one sees their wonderful tissues, formed of needles interwoven with glistering white rock-crystal, one is impressed, first with surprise, and then with admiration. Sponges are distributed from the coast to the greatest depths explored (five thousand and five metres). The littoral or shallow-water forms have a horny or calcareous skeleton, while those living at great depths have a skeleton formed of siliceous spicules, sometimes free, sometimes joined into a network. The most remarkable siliceous sponges are Holtenia, shaped like a bird's nest, having at the circumference, or else only at the base, a long *chevelure* of siliceous threads, enabling it to anchor to the bottom; Euplectellas, having the form of a long trellised horn; and Hyalonema and Chondrochladia (see fig. 1), which thrust into the mire a strong twisted fringe of long spicules, resembling spun glass. Among the siliceous sponges, in which the spicules form a kind of network, Aphrocallistes is most remarkable, a specimen of which is represented in the plate. In this sponge the needles form hexagonal meshes. Prolongations like glove-fingers, more or less distorted, detach themselves from the central part; and some of them, on coming in contact with solid bodies, or rocks, or corals, attach themselves very closely. The upper portion of the sponge (see fig. 1) is closed by an elegantly formed siliceous basket-work. As the colony increases, several of these trellises are formed.

The last animals to be mentioned, the Protozoa,

[1] Abridged from the French of H. FILHOL in *La Nature.* For previous notices see *Science*, Nos. 62, 68, 71, and 78.

are the most degraded in organization, and inhabit the bottoms of all depths. Foraminifera are so plenty at some points, that Mr. Schlumberger has counted more than a hundred thousand of them in a cubic centimetre of mire. They live at the bottom of the ocean, and not, as formerly supposed, at the surface; and the accumulations from their tests (see fig. 2) make what is termed the 'Globigerina ooze,' and will form, in the course of time, beds like those of certain geological horizons of the tertiary of Europe.

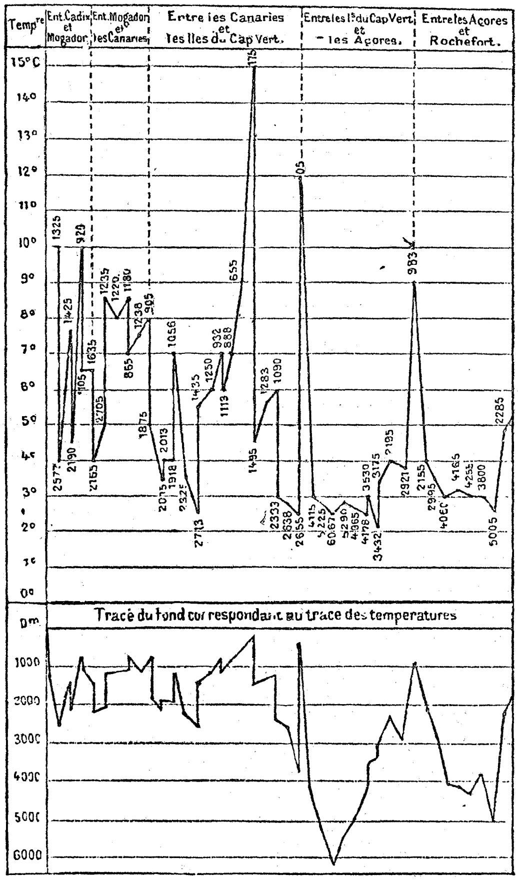


FIG. 3.—THERMOMETRIC CURVES, AND CORRESPONDING DEPTHS OF THE OCEAN-BED.

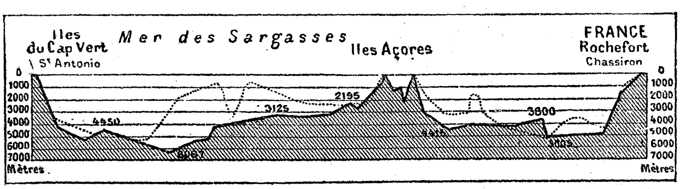


FIG. 4.—PROFILE OF THE OCEAN-BOTTOM TRAVERSED BY THE TALISMAN.

In 1868, during a cruise of the Porcupine, Mr. Carpenter and Sir Wyville Thomson discovered, among the particles of lime brought up by the dredge, a sort of jelly which made very slow movements. Within it were calcareous corpuscles of peculiar shape, which some naturalists thought to be the products of the protoplasm itself, while others thought it the *débris* of calcareous algae. Huxley called it Bathybius Haeckeli. This discovery caused a great sensation; and it was questioned whether this living slime did not at certain periods undergo evolution, and then give rise to new creatures. Wyville Thomson could not find Bathybius, and it was discovered that previous observers had been deceived by a chemical reaction. The supposed Monera was nothing more than a simple gelatinous precipitate of sulphate of lime, as it forms when concentrated alcohol is turned into sea-water. The mode of preservation of the lime had created Bathybius.

Here the general description of the results of the cruise of the Talisman is brought to a close. Yet I have thought it would be interesting to show the result of our researches on temperatures at great depths; and I have drawn two curves (fig. 3), the upper showing the thermometric records, the lower the corresponding depths. On examination it will be noticed that they do not always agree. Thus the lowest temperature we found was at 3,432 metres, while it was a little higher at 5,000 and 6,000 metres. From this the importance of deep currents, and the part they play in the distribution of life in the ocean, may be judged.

Another curve (fig. 4), drawn by Mr. Milne-Edwards, shows the profile of the bottom of the sea between the Cape Verde Islands and the Azores, on the one hand, and between these islands and France, on the other. Our relief differs considerably from that indicated on the German charts recently published (see dotted line).

KOREAN CURIOS.

POSSIBLY the most curious things in the possession of the Korean embassy, which recently visited the United States, were two thumb-rings (fig. 1), worn by the Prince Min Yong Ik one at a time, and usually on the thumb of the right hand, apparently rather more as an object to play with than as an ornament.

One of them, supposed by the prince to be jade, was found, on examination, to be serpentine; hardness 4.5, and specific gravity 2.62. It was white in color, with an oily lustre, and had on it a number of small brown stainings resembling an oxidation of iron. In the centre of each spot, apparently forming a nucleus, was a small, dendritic, moss-like marking. This ring measured 34 millimetres across the opening, the width of the opening being 22 millimetres. Its length was 28.5 millimetres. One

edge was ground off quite sharp, and the other rounded. One of the rings was noticed to be slightly flattened on one side.

FIG. 1.

The spectacles worn by the embassy (fig. 2) were rather curious as regards form and size. They were made of transparent, colorless, and smoky quartz, and are worn more to rest the eyes than as aids to sight.

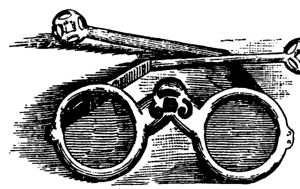


FIG. 2.

One pair, with glasses of smoky quartz, was very curiously marked, or rather streaked, showing the twinning of the crystal; and this feature was commented upon by them as a desirable one. The material of the glasses is obtained from Kyeung Ju, in the south-western part of the province, and is manufactured by thirteen spectacle-makers of note; there being also, in addition to these, a number of inferior workmen. The frames are made of horn, measuring five inches and a half in length, and two inches in width across the glasses.

The amber beads which they wear (fig. 3) are all imported from Europe, and a peculiar, long, rounded one was used as a button.

FIG. 3.

A curious button (fig. 4) is also used by them. It is worn on each side of the head, behind the ears, sewed to a velvet band; and a string attached to the hat passes under the button to hold the hat on the head. When made of gold, they denote the highest rank, and are worn only by the prince.

Every Korean woman wears two rings, always exactly similar in every respect, and as a rule perfectly plain. These are half oval in form, and are made either of gold, silver, amber, or coral. The coral, until recently, has been brought from China, and must have been cut from very large branches of this material.

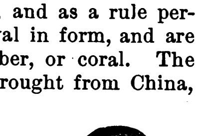


FIG. 4.

They themselves say that their ladies are the best, or rather the most elaborately, dressed women in the world. In confirmation of this, the prince gave as his reason for leaving his wife at home, that her clothes would not have stood the wear of the journey.

The prince described some crystals which must be the most remarkable yet known for quartz, if there is no error in his statements. They were described as hexagonal in form, and in length six times the height of a man, while over one foot across. After being shown a sketch of stalactites, the prince made a drawing of the crystals which showed the distinct terminal planes of quartz; and he insisted that they were not the same as the stalactites. They were described as red and white in color. It is barely possible from their form, that they are crystals of trap; but from their color and terminations it would seem otherwise. They are found rising from the water at Ohoong Sokh Chung, Kong Won Do, Tsing Chun county, a province on the east coast of Korea.

GEORGE F. KUNZ.

THE HISTORY OF AMERICAN INSTITUTIONS.

Johns Hopkins university studies in historical and political science. HERBERT B. ADAMS, editor. Vol. i. Local institutions. Baltimore, *University*, 1883. [470] p. 8°.

THE first volume of the Johns Hopkins university 'Studies in historical and political science' for the year 1883 is devoted to the subject of American institutions of local self-government, — a subject which has heretofore been greatly neglected, or, at any rate, treated in only a fragmentary and irregular manner. The present is the first attempt made to investigate it comprehensively and systematically; not exhaustively, by any means, or with any pretence to completeness, even of outline. Certainly, no person would look, in a year of independent studies, for any thing more than a commencement of so large a work. As the second year's issue does not propose to continue the same line of investigation, it seems fitting to examine the results of last year's labors, and determine what they have accomplished, and what they leave to be accomplished.

The studies before us embrace a wide range and variety of subject, including no fewer states than Massachusetts, Connecticut, Pennsylvania, Maryland, South Carolina, Michigan, and Illinois, — states far enough apart, one would think, in origin and character, to include every phase of American municipal life. Notwithstanding the admirable judgment, however, with which the subjects have been selected, it will be seen at a glance that there are vital omissions. New York, which has afforded the model for municipal government for almost the entire north-west, and which has some traces of the Dutch system still left; Virginia, the ruling state of the south, and

representing the cavalier instincts of English royalists; the survivals of French institutions in Louisiana, and of Spanish farther west and in Florida, — these, at least, must come into a complete scheme; and those of New York will probably be found the most important of all, so far as the genesis of American local institutions is concerned.

The principal line of investigation in this group of studies has been conducted by Prof. H. B. Adams, the editor of the series, and has been devoted to showing the organic connection between the town institutions of New England and the corresponding institutions of Old England. No less than five papers are devoted to this end, — No. 2, 'The Germanic origin of New-England towns;' No. 4, 'Saxon tithing-men in America;' No. 8, 'Norman constables in America;' and Nos. 9 and 10, 'Village communities of Cape Anne and Salem.' These five papers contain a very interesting account of the corporate features, and the most primitive magistracies of the New-England towns.

The corporate quality, the continuity of existence, the identity of organization and of magistrates, — all these points are well brought out in these papers; but the most important feature of the New-England town-system remains yet to be explained, — the town-meeting, which John Adams placed with good right as one of the four corner-stones of New-England democracy.

The New-England town-meeting is a wholly unique institution. There have been popular assemblies often in history; but the New-England town-meeting differs from all these by radical and fundamental features. Not that it possesses any attribute of real sovereignty, or even any independent original action: it is an institution of wholly subordinate character, and with derived powers, as is shown by the fact that its sphere of action is absolutely limited by the specifications of the warrant. No business can legally come before the meeting which is not definitely stated in this instrument.

A more important characteristic — that, indeed, in which it differs essentially from every other popular assembly — is what we may call the *parliamentary* character of its procedure. Just as the British parliament, representing the people of Great Britain, sits in judgment upon the king and ministers, who hold their places by its will, and subjects them to a rigid accountability, just so the people of the New-England towns, assembled in March meeting, supersede for the time the town magistrates. For that day the selectmen are private citizens. The first business of the meeting is 'to choose a moderator;' and the moderator is the officer of the meeting, wholly independent of the selectmen, just as the speaker is the officer of parliament, wholly independent of king and council. The town-meeting, like parliament, holds the strings of the purse, and not merely votes taxes, but appropriates them to definite objects of expenditure.

This is a feature peculiar to the New-England popular assembly: it is not English, it is not even Teutonic. The English court-leet and folk-mote, the Frank *mal*, as well as the Athenian *ecclesia* and the Roman *comitia*, were presided over by the magistrate who summoned them; and the same is true of the town-meetings in most other parts of the United States. It is from the effective responsibility thus exercised over the town-officers by the body of the citizens, that the peculiar vitality and democratic character of the New-England town-system, noticed by De Tocqueville and others, are derived. The origin of this remarkable feature seems the most interesting and important question in the history of New-England local institutions.

The western states have, as a rule, modelled their town-system upon that of New York rather than of New England, — a system better in many respects, but differing from it chiefly in the absence of the town-meeting. It follows, as was remarked before, that the New-York local institutions are historically the most important of all, and that the most important problem to be solved in these investigations is the cause of this divergence in institutions between two English communities in the same latitude, and separated only by an imaginary boundary-line. Maine and New Hampshire, proprietary colonies, fell spontaneously into the system that prevailed in the charter colonies south of them; perhaps, in part, for the reason that they were, one temporarily, and the other for a much longer period, annexed to Massachusetts. How did it come about that this group adopted this unique system of self-government, while New York, their nearest neighbor, developed so different a system?

This question finds a partial answer in Mr. Gould's paper (No. 3) upon local government in Pennsylvania, in which the policy of the Duke of York is briefly described. This "was a close imitation of the English system: it recognized the old municipal divisions of ridings, towns, and parishes." It is just at this point that we need further elucidation, Mr. Gould's theme confining him to the special

forms of local government developed under the proprietary government of Pennsylvania. 'Towns and parishes,' — these are in English institutions, as a rule, identical; the parish being the ecclesiastical organization of the township, as the manor is its feudal form. Now, it is a significant fact, that south of Mason and Dixon's line the manor was the form adopted, in which the popular assembly was the court-leet. One of the most interesting and valuable papers of the whole series is that of Mr. Johnson (No. 7), upon old Maryland manors, with the records of a court-leet and a court-baron; which records "are the first of their kind that have been utilized by students of Maryland history." But the parish, primarily ecclesiastical, though also used for civil purposes, existed by the side of the manor, as shown by Mr. Ingle, in his paper (No. 6) on parish institutions of Maryland, and by Mr. Ramage, in his paper (No. 12) on local government in South Carolina. The parish, in the beginning regularly conterminous with the town, was also found in New England, where the Congregational Church was established by law, as the Episcopal was in Maryland and South Carolina.

Now, it is an important fact, in connection with this inquiry, that it was just in the period before the planting of the English colonies in America, probably as a result of the Reformation, that the parish became the regular organ of local self-government in England. Its vestry was an assembly of all inhabitants of the parish, not for church concerns alone, but for all matters of public interest, thus taking the place of the old court-leet, or popular court of the township. It is probably from this vestry that the New-England town-meeting was derived, with considerable modifications and enlargement of powers. It was, it must be noticed, fully as ecclesiastical in character as the vestry, none but church-members being allowed to take part in it; and, a significant fact, the name of its elected president, 'moderator,' appears to have been taken from the usage of the Scotch church assemblies. The English vestry was regularly presided over by the rector.

It appears probable, therefore, that, while the New-England 'town' was a direct descendant of the English town, its assembly, or town-meeting, was not derived directly from the court-leet, or primitive popular assembly, which had become feudalized, and brought under the authority of the lord of the manor, but from the vestry, — the form of public assembly which alone possessed vitality and a certain democratic character at the close of the sixteenth century. It may be inferred from Mr. Gould's statement, that the New-York town-system had the same origin; but for some reason its assembly never received the remarkable development of that of New England, and the town itself was reduced to comparative insignificance by the establishment of a county-system of a character intermediate between that of the south, where the county is the principal civil division, and that of New England, where it is hardly more than a group of towns.[1] The system thus created, the relation between county and town established in New-York, with the distinctive town-system which exists in connection with it, may fairly be called the American system. It has spread in the west to the exclusion of the New-England system; and, as is shown in Mr. Shaw's interesting paper (No. 3), on local government in Illinois, it is driving out the southern system, even where the latter had the start. It should be noticed, at the same time, that the Illinois town-meeting, differing from that of most of the states of the north-west, is shown by Mr. Shaw to have been modelled upon that of New England.

The admirable work done in the first series of these papers needs, therefore, to be supplemented in two directions in particular. First, the Virginia county-system, that which appears to have controlled local institutions generally in the south-west, should be described. Second, it needs to be shown how the New-York county and town system, which at present exercises a controlling influence throughout the north-west, and is successfully rivalling the Virginia system, even on its own ground, came into existence.

There remain several interesting subjects, discussed in these papers, into which we have not space to enter. It will be only necessary to mention Mr. Johnston's 'Genesis of a New-England state' (No. 11), in which the town principle is shown to have had a peculiar and remarkable career in Connecticut; Mr. Bemis, upon local government in Michigan and the north-west (No. 5); and Professor Adams's illustrations (already mentioned) of land communities in Massachusetts. This subject, it may be stated, has been examined with the aid of original documents, and with considerable fulness of detail, by Mr. Melville Egleston, in

[1] [In Rhode Island the towns have some of the functions which counties have in Massachusetts, and the power of the county becomes far less important. For instance: in Massachusetts the county lays out highways; in Rhode Island this is the function of the town, and it sometimes happens that roads on opposite sides of a town-line do not connect. — Ed.]

a pamphlet entitled 'The land-system of the New-England colonies,' — a work which well supplements the series before us.

THE EXPLORING VOYAGE OF THE CHALLENGER.

(Third notice.)[1]

ONE of the most important of all the outcomes of the expedition is undoubtedly Alexander Agassiz's memoir upon the Echinoidea (vol. iii., 321 p., 45 pl.) which occupies fully two-thirds of one of the massive volumes of the report. Mr. Agassiz's personal acquaintance with all known types of Echinoidea, recent and fossil, gives him an advantage as an authority over all his contemporaries; and, without some such special training, it would have been a matter at least of extreme difficulty to decipher the complex relations of the multitude of singular forms intermediate between the faunas of ancient and modern times, which have been brought to light by the Challenger expedition. The value of these collections may best be shown by a bit of statistics. When the author's 'Revision of the Echini' was publishing (1872–74), there were enumerated 207 species, distributed in 89 genera, including 2 deep-sea species discovered by the Porcupine, and 13 by Count Pourtalès. In the general list which accompanies this report, there are 297 species and 107 genera enumerated, making, in all, 90 species and 25 genera added to the former list, in spite of the reduction in number by the cancelling of nominal species. This shows that 80 species of deep-sea echinoids have been discovered since those of Mr. Pourtalès, and that fully one-third of the whole number of known species of Echinoidea have been discovered since the days of deep-sea dredgings. It would seem absurd to attempt, in a review so limited as this, even to call attention to the main points of interest in a memoir of such extent as this. The most instructive chapters for biologists in general, however, are those upon the "character of systematic affinity of allied groups of Echinoidea" (p. 18), upon the "relations of the Jurassic Echinoidea to the echinid faunas of the present day" (p. 19), upon the "connection between the cretaceous and recent echinid faunas" (p. 25), and upon the "geographical range of the continental and abyssal species" (p. 246); in which latter, especially, is pursued a line of thought of great importance to all those who are considering the problems of the origin of marine faunas. Roetter's lithographic delineations are especially worthy of admiration.

[1] For previous notices see Nos. 66, 79.

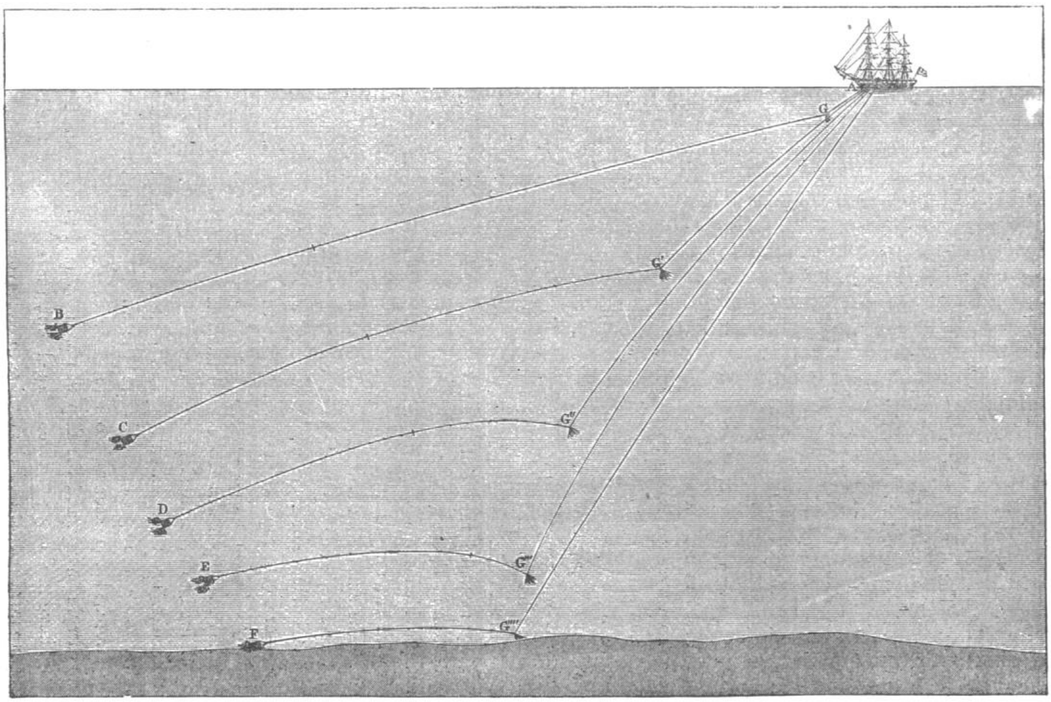
Another paper, especially satisfactory by reason of its extent and completeness, is Col. Theodore Lyman's report on the Ophiuroidea (vol. v., 387 p., 48 pl.). This is a monograph of all the known species (500 in number), and is illustrated by about 750 beautiful lithographic figures, drawn by L. Trouvelot. Mr. Lyman's introductory remarks, with his diatribes against genealogical tables and theories of phylogeny, will delight even those whom he intends to criticise, so genial and keen is the humor with which his views are expressed; and there is something refreshing, too, in the curt, sharp-cut phrases in which his general conclusions are formulated. Exceedingly interesting, too, is the manner in which the writer has succeeded in framing his diagnoses of species, genera, and families, in simple words, half of them of one syllable, and Anglo-Saxon in origin at that. He surely has fulfilled his intention "not to add to the jargon in which zoölogy is now smothering," — a jargon, he declares, "such as Molière would scarcely have ventured to put in the mouth of the medical faculty in his Malade imaginaire." The number of new species added by the Challenger was 170, with 21 new genera. The tables of distribution, geographical, bathymetrical, and thermal, with the 'brief reflections on their indications,' are suggestive in many directions, and we regret that the reflections may not here be quoted at length. In general terms, it may be said "that a very large proportion of the species live exclusively on the littoral zone, and that therein are included species both of cold and of hot water, though the number of the latter is much the larger. Then there is a large fauna of 50 species, which live exclusively below 1,000 fathoms, and which have to endure a degree of cold near to freezing, an enormous water-pressure, and an entire absence of sunlight. Between these extremes there are large groups whose favorite, or even necessary, habitat is restricted to given depths." Sixteen genera do not go lower than 30 fathoms; and they, without exception, inhabit warm seas. "This proves that certain groups demand a high temperature, and cannot accommodate themselves to a lower one. Should any of them, therefore, be found fossil, it would be reasonable to infer that the horizon was a shallow covered by warm water. Nine genera have not yet been found above 1,000 fathoms:" their occurrence, therefore, as fossils, might denote a geological bottom of great

depth, and covered by cold water of very heavy pressure.

The reflections of the author upon the thermal tables are to the effect that the warm-water species, which are also of comparatively shallow water, are by far the most numerous, — a proportion which suggests that heat, light, and small pressure tend to produce variety in form and structure. "Yet," it is remarked, "there is not that vast difference between deep cold species and shallow warm ones which might reasonably be looked for, on the theory that so-called natural forces are alone potent to effect change."

The work on fossil species is simply a review of the present state of knowledge, which is admitted to be very unsatisfactory. At present it cannot be said that a single fossil genus is identical with the living; but there is much unstudied material in museums. The index is a workmanlike conclusion to a most scholarly production; and our transatlantic fellow-workers, who insist in their reviews upon calling the author Professor Lyman, will be surprised to know that he is not a professional zoölogist, but that science has been simply his diversion, in the midst of many other time-consuming occupations, as legislator, fish-culturist, farmer, and politician.

Two papers more will complete work upon the echinoderms, and these are being prepared by Mr. P. H. Carpenter of Eton college. The Comatulidae were his from the start; and the stalked crinoids, which were reserved for his personal study by the late director, will be completed by him, and reported upon in a paper under the joint authorship of Thomson and Carpenter.



THE RELATIVE POSITIONS OF THE SHIP, THE MESSENGER-WEIGHTS, THE TOGGLE (G), AND THE DREDGE (B, ETC.), AT DIFFERENT STAGES OF PAYING-OUT FROM THE CHALLENGER.

Work upon the Coelenterata is progressing at a satisfactory rate. The Alcyonarians are still unpublished, the work being in the hands of Prof. E. Percival Wright.

Professor Albert von Kölliker disposes of the Pennatulida in an essay of forty-one pages (vol. i., 41 p., 11. pl.), with 61 beautifully executed lithographic figures. The expedition brought home 38 species of 19 genera, of which 27 species and 7 genera were new to science. The author formerly believed the great majority of the Pennatulida to occur at depths

of 20 fathoms or less; but the number of deep-sea forms now known is nearly equal to that of the shore-species of shallow-water forms. The deep-water forms appear, however, to be almost absent from the Atlantic, the Pacific, and the south polar seas. The simpler forms of the Pennatulida, especially those with sessile polyps, inhabit the great depths. These, of which the Protoptilidae and Umbellulidae are the most numerous, are believed to be the oldest, 'the last remnants of an extinct primary creation;' and of them the Challenger discovered a large number of species, with a wide distribution. This conclusion of the author is of especial interest, since the presence of their less complex representatives in deep water has been shown to be the rule in other groups of invertebrates as well.

The report upon the Actiniaria, by Professor Richard Hertwig of Königsberg (vol. vi., 136 p., 14 pl.), is a very laborious and exhaustive piece of work; and the fulness of the descriptions of anatomical details, as well as the elaboration of the drawings, are causes of surprise, when one remembers that zoölogists have hitherto usually refused to work with shrivelled alcoholic preparations; unless, indeed, drawings have been made from the living animals. 39 species were examined, of which 30 were new. The reader shares with the author his manifest disappointment, that the study of this group suggests answers to so few of the questions which naturally arise. At the same time, we cannot fail to recognize the importance of the author's concluding remarks, in which he demonstrates that life in the great depths has a visible influence upon the organization of the Actiniae, especially in the form of the tentacles, and shows how the nature of the food of the deep-sea forms has probably favored the transformation of the long tentacles of the ordinary littoral forms into tubes, or even simple openings in the oral disk. In the diverse arrangement of the septa in deep-sea forms, he finds, also, an important indication; namely, that the diversity in the structure of the Anthozoa was formerly much greater than it is at present, and that the remains of this diversity have been more extensively preserved in the depths of the sea than in the shallow waters.

Professor Hertwig makes frequent allusions to the work of the American authorities Verrill and Couthouy; and to the attainments of the former, in this department of zoölogy, he pays a well-merited compliment.

Prof. Henry N. Moseley of Oxford has printed his report upon the corals, chiefly in the group Hydrocorallinae, Helioporidae, and Madreporaria, which is worked out with the author's customary skill and minuteness. Many valuable papers on the structure of corals, based upon Challenger material, have also been published by Professor Moseley in the *Philosophical transactions*, and elsewhere.

Professor Ernst Haeckel's paper on the deep-sea Medusae (vol. iv., 259 p., 32 pl.) is, in its first half, devoted to an elaborate discussion of the general morphology and histology and phylogeny of the Medusae, having special reference to the new morphological facts derived from his study of this collection. The essentials of this paper were embodied by the author in his 'System der Medusen,' published in 1879; and it has already been reviewed in *Science*, vol. i. p. 195.

Professor Allman prints the first instalment of his memoir on the Hydroida, which consists of a report upon the Plumularidae (vol. vii., 55 p., 20 pl.). The introductory remarks upon the general morphology are of great importance as bringing the subject up to the present standard of information. It is pleasant to note the appreciation with which the work of Mr. Fewkes is now and again referred to. Out of the 31 species referred to, 26 are new, and a number of genera are for the first time characterized. Professor Allman asserts, that, in tropical and sub-tropical regions, this group has its maximum in multiplicity of forms, in the size of the colonies, and in individual profusion. He also calls attention to the apparent existence of two centres of maximum plumularian development, — an eastern one, in the warm seas of the East-Indian archipelago; and a western one, in the waters which surround the West-Indian Islands, and bathe the eastern shores of central and equinoctial America, — centres which are nearly coincident with those of maximum development in the Chiroptera.

Dr. William B. Carpenter's memoir on the genus Orbitolites (vol. vii., 47 p., 8 pl.) contains a *résumé* of an investigation which has been carried on by this veteran in deep-sea research, extending over more than a third of a century. The discussion of the four species under examination occupies but a small portion of the paper, which really deals with the entire group of Foraminifera, and concludes with a 'Study of the theory of descent,' in which the power of natural selection to originate any varietal forms whatever is distinctly denied.

The report on the Calcarea, by N. Poljaeff, of the University of Odessa (vol. viii., 76 p.,

9 pl.), is in the main devoted to developing a new system of classification for the group, and to the criticism of Professor Haeckel's monograph, 'Die kalkschwämme.' 30 species were brought in by the Challenger, 23 of which were new. All these are elaborately described, and illustrated by most exquisite plates, chiefly drawn by the author. Mr. Poljaeff expresses the hope, "that the systematic arrangement of the group Calcarea, here proposed, will serve as a sufficiently sure basis for further investigations," — a hope which will be shared by all, but which in the present unsettled state of opinion among specialists in this department, and in view of the scarcity of material for investigation, is perhaps a trifle premature.

Other papers upon the Protozoa are promised, but are mostly far down in the list. The Hexactinellid sponges are assigned to Prof. F. E. Schulze; the Tetractinellidae, to Professor Solles; the Monactinellidae, to Mr. S. O. Ridley.' Mr. H. B. Brady's paper on the Foraminifera, and Professor Haeckel's on the Radiolaria, will probably first be printed.

G. BROWN GOODE.

Smithsonian institution.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

RECENT PROGRESS IN PHYSICS.[1]

AFTER referring to what at first appeared a rather startling experiment, the holding of a meeting of the association outside of Great Britain, and to the undoubted pleasure and benefit the members would receive from their visit to Canada, Lord Rayleigh spoke of the loss the association had met in the death of Sir W. Siemens, and gave a brief account of Siemens's scientific work. He called attention to the fact that it is now some years since the presidential chair had been occupied by a physicist, and, while regretting that he should be called on to preside when the association met in a country of so great interest to the naturalists, he proposed to do the best he could by giving a sketch of the progress in late years of physical science.

It is one of the difficulties of the task, that subjects as distinct as mechanics, electricity, heat, optics, and acoustics, to say nothing of astronomy and meteorology, are included under physics. Any one of these may well occupy the lifelong attention of a man of science; and to be thoroughly conversant with all of them is more than can be expected of any one individual, and is probably incompatible with the devotion of much time and energy to the actual advancement of knowledge. Another difficulty incident to the task, which must be faced but cannot be overcome, is that of estimating rightly the value, and even the correctness, of recent work. It is not always that which seems at first the most important that proves in the end to be so. The history of science teems with examples of discoveries which attracted little notice at the time, but afterwards have taken root downwards, and borne much fruit upwards.

One of the most striking advances of recent years is in the production and application of electricity upon a large scale. The dynamo-machine is, indeed, founded upon discoveries of Faraday, now more than half a century old; but it has required the protracted labors of many inventors to bring it to its present high degree of efficiency. Looking back at the matter, it seems strange that progress should have been so slow, not merely in details of design, the elaboration of which must always require the experience of actual work, but with regard to the main features of the problem. It would almost seem as if the difficulty lay in want of faith. Long ago it was recognized that electricity derived from chemical action is (on a large scale) too expensive a source of mechanical power, notwithstanding the fact that (as proved by Joule in 1846) the conversion of electrical into mechanical work can be effected with great economy. From this it is an evident consequence that electricity may advantageously be obtained from mechanical power; and one cannot help thinking, that, if the fact had been borne steadily in mind, the development of the dynamo might have been much more rapid. But discoveries and inventions are apt to appear obvious, when regarded from the stand-point of accomplished fact; and he drew attention to the matter only to point the moral that we do well to push the attack persistently when we can be sure beforehand that the obstacles to be overcome are only difficulties of contrivance, and that we are not vainly fighting unawares against a law of nature.

The present development of electricity on a large scale depends, however, almost as much upon the incandescent lamp as upon the dynamo. The success of these lamps demands a very perfect vacuum, — not more than about one-millionth of the normal quantity of air should remain, — and it is interesting to recall, that, twenty years ago, such vacua were rare even in the laboratory of the physicist. It is pretty safe to say that these wonderful results would never have been accomplished had practical applications alone been in view. The way was prepared by an army of scientific men, whose main object was the advancement of knowledge, and who could scarcely have imagined that the processes which they elaborated would soon be in use on a commercial

[1] Address to the British association for the advancement of science at Montreal, Aug. 27, 1884, by the Right Hon. Lord Rayleigh, M.A., D.C.L., F.R.S., F.R.A.S., F.R.G.S., professor of experimental physics in the University of Cambridge, president of the association.

scale, and intrusted to the hands of ordinary workmen.

The requirements of practice react in the most healthy manner upon scientific electricity. Just as in former days the science received a stimulus from the application to telegraphy, under which every thing relating to measurement on a small scale acquired an importance and development for which we might otherwise have had long to wait, so now the requirements of electric lighting are giving rise to a new development of the art of measurement upon a large scale, which cannot fail to prove of scientific as well as practical importance. Mere change of scale may not at first appear a very important matter, but it is surprising how much modification it entails in the instruments, and in the processes of measurement. For instance: the resistance-coils on which the electrician relies, in dealing with currents whose maximum is a fraction of an ampère, fail altogether when it becomes a question of hundreds, not to say thousands, of ampères.

The powerful currents which are now at command constitute almost a new weapon in the hands of the physicist. Effects which in old days were rare, and difficult of observation, may now be produced at will on the most conspicuous scale. Consider, for a moment, Faraday's great discovery of the 'magnetization of light,' which Tyndall likens to the Weisshorn among mountains, as high, beautiful, and alone. It is even possible that it might have eluded altogether the penetration of Faraday, had he not been provided with a special quality of very heavy glass. At the present day these effects may be produced upon a scale that would have delighted their discoverer, a rotation of the plane of polarization through 180° being perfectly feasible. With the aid of modern appliances, Kundt and Röntgen in Germany, and H. Becquerel in France, have detected the rotation in gases and vapors, where, on account of its extreme smallness, it had previously escaped notice.

Reference was made to the importance the question of the magnetic saturation of iron was assuming in the discussion of the problems arising in connection with the dynamo-machines, and to the work of Rowland and Stoletow on the theory of the behavior of soft iron under varying magnetic conditions.

The introduction of powerful alternate-current machines by Siemens, Gordon, Ferranti, and others, is likely also to have a salutary effect in educating those so-called practical electricians whose ideas do not easily rise above ohms and volts. It has long been known, that, when the changes are sufficiently rapid, the phenomena are governed much more by induction, or electric inertia, than by mere resistance. On this principle, much may be explained that would otherwise seem paradoxical. To take a comparatively simple case, conceive an electro-magnet wound with two contiguous wires, upon which acts a given rapidly periodic electromotive force. If one wire only be used, a certain amount of heat is developed in the circuit. Suppose, now, that the second wire is brought into operation in parallel, — a proceeding equivalent to doubling the section of the original wire. An electrician accustomed only to constant currents would be sure to think that the heating-effect would be doubled by the change, as much heat being developed in each wire separately as was at first in the single wire; but such a conclusion would be entirely erroneous. The total current, being governed practically by the self-induction of the circuit, would not be augmented by the accession of the second wire; and the total heating-effect, so far from being doubled, would, in virtue of the superior conductivity, be halved.

During the last few years, much interest has been felt in the reduction to an absolute standard of measurement of electromotive force, current, resistance, etc.; and to this end many laborious investigations have been undertaken, some of the results being embodied in the resolves of the Conference of electricians assembled at Paris.

For the measurement of current strength, advantage may be taken of Faraday's law, that the quantity of metal decomposed in an electrolytic cell is proportional to the whole quantity of electricity that passes. The best metal for the purpose is silver, deposited from a solution of the nitrate or of the chlorate. The results recently obtained by Professor Kohlrausch and by Lord Rayleigh are in very good agreement; and the conclusion that one ampère, flowing for one hour, decomposes 4.025 grains of silver, can hardly be in error by more than a thousandth part. This number being known, the silver voltameter gives a ready and very accurate method of measuring currents of intensity, varying from a tenth of an ampère to four or five ampères.

The beautiful and mysterious phenomena attending the discharge of electricity in nearly vacuous spaces have been investigated and in some degree explained by De la Rue, Crookes, Schuster, Moulton, and the lamented Spottiswoode, as well as by various able foreign experimenters; and a remarkable observation by Hall of Baltimore, from which it appeared that the flow of electricity in a conducting-sheet was disturbed by magnetic force, has been the subject of much discussion.

Without doubt, the most important achievement of the older generation of scientific men has been the establishment and application of the great laws of thermo-dynamics, or, as it is often called, the mechanical theory of heat. The first law, which asserts that heat and mechanical work can be transformed one into the other at a certain fixed rate, is now well understood by every student of physics; and the number expressing the mechanical equivalent of heat resulting from the experiments of Joule has been confirmed by the researches of others, and especially of Rowland. But the second law, which practically is even more important than the first, is only now beginning to receive the full appreciation due to it. One reason of this may be found in a not unnatural confusion of ideas. Words do not always lend themselves readily to the demands that are made upon them by a growing science; and the almost unavoidable use of the word 'equivalent' in the state-

ment of the first law is partly responsible for the little attention that is given to the second, for the second law so far contradicts the usual statement of the first as to assert that equivalents of heat and work are not of equal value. While work can always be converted into heat, heat can only be converted into work under certain limitations. For every practical purpose, the work is worth the most; and, when we speak of equivalents, we use the word in the same sort of special sense as that in which chemists speak of equivalents of gold and iron. The second law teaches us that the real value of heat, as a source of mechanical power, depends upon the temperature of the body in which it resides: the hotter the body, in relation to its surroundings, the more available the heat.

In order to see the relations which obtain between the first and the second law of thermo-dynamics, it is only necessary for us to glance at the theory of the steam-engine. Not many years ago, calculations were plentiful, demonstrating the inefficiency of the steam-engine, on the basis of a comparison of the work actually got out of the engine with the mechanical equivalent of the heat supplied to the boiler. Such calculations took into account only the first law of thermo-dynamics, which deals with the equivalents of heat and work, and had very little bearing upon the practical question of efficiency, which requires us to have regard, also, to the second law. According to that law, the fraction of the total energy which can be converted into work, depends upon the relative temperatures of the boiler and condenser; and it is therefore manifest, that, as the temperature of the boiler cannot be raised indefinitely, it is impossible to utilize all the energy which, according to the first law of thermo-dynamics, is resident in the coal.

On a sounder view of the matter, the efficiency of the steam-engine is found to be so high that there is no great margin remaining for improvement. The higher initial temperature possible in the gas-engine opens out much wider possibilities; and many good judges look forward to a time when the steam-engine will have to give way to its younger rival.

To return to the theoretical question, we may say, with Sir W. Thomson, that, though energy cannot be destroyed, it ever tends to be dissipated, or to pass from more available to less available forms. No one who has grasped this principle can fail to recognize its immense importance in the system of the universe. Every change — chemical, thermal, or mechanical — which takes place, or can take place, in nature, does so at the cost of a certain amount of available energy. The foundations laid by Thomson now bear an edifice of no mean proportions, thanks to the labors of several physicists, among whom must be especially mentioned Willard Gibbs, and Helmholtz. The former has elaborated a theory of the equilibrium of heterogeneous substances, wide in its principles, and, we cannot doubt, far-reaching in its consequences. In a series of masterly papers, Helmholtz has developed the conception of *free energy*, with very important applications to the theory of the galvanic cell. He points out, that the mere tendency to solution bears, in some cases, no small proportion to the affinities more usually reckoned chemical, and contributes largely to the total electromotive force. Also, in England, Dr. Alder Wright has published some valuable experiments relating to the subject.

From the further study of electrolysis, we may expect to gain improved views as to the nature of the chemical reactions, and of the forces concerned in bringing them about. Lord Rayleigh did not consider himself qualified to speak on recent progress in general chemistry; but if he might, without presumption, venture a word of recommendation, it would be in favor of a more minute study of the simpler chemical phenomena.

Under the head of scientific mechanics, it is principally in relation to fluid motion that advances may be looked for. The important and highly practical work of the late Mr. Froude in relation to the propulsion of ships is, doubtless, known to most. Recognizing the fallacy of views widely held, as to the nature of the resistance to be overcome, he showed, that, in the case of fair-shaped bodies, we have to deal almost entirely with resistance dependent upon skin-friction; and, at high speeds, upon the generation of surface-waves, by which energy is carried off. Although Professor Stokes, and other mathematicians, had previously published calculations pointing to the same conclusion, there can be no doubt that the view generally entertained was very different. Mr. Froude's experiments have set the question at rest in a manner satisfactory to those who had little confidence in theoretical prevision. Although the magnitude of skin-friction varies with the smoothness of the surface, we have no reason to think that it would disappear at any degree of smoothness consistent with an ultimate molecular structure. That it is connected with fluid viscosity is evident enough, but the *modus operandi* is still obscure.

Some important work bearing upon the subject has recently been published by Prof. O. Reynolds, who has investigated the flow of water in tubes as dependent upon the velocity of motion, and upon the size of the bore. The laws of motion in capillary tubes, discovered experimentally by Poiseuille, are in complete harmony with theory. The resistance varies as the velocity, and depends in a direct manner upon the constant of viscosity. But, when we come to the larger pipes and higher velocities with which engineers usually have to deal, the theory which presupposes a regularly stratified motion evidently ceases to be applicable, and the problem becomes essentially identical with that of skin-friction in relation to ship-propulsion. Professor Reynolds has traced with much success the passage from the one state of things to the other, and has proved the applicability, under these complicated conditions, of the general laws of dynamical similarity, as adapted to viscous fluids by Professor Stokes.

As also closely connected with the mechanics of viscous fluids, an important series of experiments upon the friction of oiled surfaces, recently executed by Mr. Tower for the Institution of mechanical engineers, must not be overlooked. When the lubrica-

tion is adequate, the friction is found to be nearly independent of the load, and much smaller than is usually supposed, giving a coefficient as low as a thousandth. When the layer of oil is well formed, the pressure between the solid surfaces is really borne by the fluid; and the work lost is spent in shearing, that is, in causing one stratum of the oil to glide over another.

The nature of gaseous viscosity, as due to the diffusion of momentum, has been made clear by the theoretical and experimental researches of Maxwell. A flat disk, moving in its own plane between two parallel solid surfaces, without contact, is impeded by the necessity of shearing the intervening layers of gas; and the hinderance is proportional to the velocity of the motion and to the viscosity of the gas, so that, under similar circumstances, this effect may be taken as a measure, or rather definition, of the viscosity. From the dynamical theory of gases, to the development of which he contributed so much, Maxwell drew the startling conclusion that the viscosity of a gas should be independent of its density; that within wide limits the resistance to the moving disk should be scarcely diminished by pumping out the gas, so as to form a partial vacuum. Experiment fully confirmed this theoretical anticipation, — one of the most remarkable to be found in the whole history of science, — and proved that the swinging disk was retarded by the gas as much when the barometer stood at half an inch as when it stood at thirty inches. It was obvious, of course, that the law must have a limit; that at a certain point of exhaustion the gas must begin to lose its power; and Lord Rayleigh remembers discussing with Maxwell, soon after the publication of his experiments, the whereabouts of the point at which the gas would cease to produce its ordinary effect. His apparatus, however, was quite unsuited for high degrees of exhaustion; and the failure of the law was first observed by Kundt and Warburg, at pressures below one millimetre of mercury. Subsequently the matter has been thoroughly examined by Crookes, who extended his observations to the highest degrees of exhaustion, as measured by MacLeod's gauge. Perhaps the most remarkable results relate to hydrogen. From the atmospheric pressure of seven hundred and sixty millimetres, down to about half a millimetre of mercury, the viscosity is sensibly constant. From this point to the highest vacuum, in which less than a millionth of the original gas remains, the coefficient of viscosity drops down gradually to a small fraction of its original value.

Such an achievement as the prediction of Maxwell's law of viscosity has, of course, drawn increased attention to the dynamical theory of gases. At the same time, the theory presents serious difficulties; and we can but feel, that, while the electrical and optical properties of gases remain out of relation to the theory, no final judgment is possible.

In optics, attention has naturally centred upon the spectrum. By the use of special photographic methods, Abney has mapped out the peculiarities of the invisible rays lying beyond the red with such success that our knowledge of them begins to be comparable with that of those visible to the eye. Equally important work has been done by Langley, using a refined invention of his own, based upon the principle of Siemens's pyrometer. Interesting results have also been obtained by Becquerel, whose method is founded upon a curious action of the ultra-red rays in enfeebling the light emitted by phosphorescent substances. One of the most startling of Langley's conclusions relates to the influence of the atmosphere in modifying the quality of solar light. By the comparison of observations made through varying thicknesses of air, he shows that the atmospheric absorption tells most upon the light of high refrangibility; so that, to an eye situated outside the atmosphere, the sun would present a decidedly bluish tint.

Cornu has made use of the fact that the refrangibility of a ray of light is altered by a motion of the luminous body to or from the observer to determine whether a line is of solar or atmospheric origin. For this purpose a small image of the sun is thrown upon the slit of the spectroscope, and caused to vibrate two or three times a second, in such a manner that the light entering the instrument comes alternately from the advancing and retreating limbs. As the sun is itself in rotation, and thus the position of a solar spectral line is slightly different according as the light comes from the advancing or from the retreating limb, a line due to absorption within the sun appears to tremble, as the result of slight alternately opposite displacements. But, if the seat of the absorption be in the atmosphere, it is a matter of indifference from what part of the sun the light originally proceeds; and the line maintains its position in spite of the oscillation of the image upon the slit of the spectroscope.

The instrumental weapon of investigation, the spectroscope itself, has made important advances. The magnificent gratings of Rowland are a new power in the hands of the spectroscopists, and, as triumphs of mechanical art, seem to be little short of perfection.

The great optical constant, the velocity of light, has been the subject of three distinct investigations by Cornu, Michelson, and Forbes. As may be supposed, the matter is of no ordinary difficulty, and it is therefore not surprising that the agreement should be less decided than could be wished. From their observations, which were made by a modification of Fizeau's method of the toothed wheel, Young and Forbes drew the conclusion that the velocity of light *in vacuo* varies from color to color, to such an extent that the velocity of blue light is nearly two per cent greater than that of red light. Such a variation is quite opposed to existing theoretical notions, and could only be accepted on the strongest evidence. Mr. Michelson, whose method (that of Foucault) is well suited to bring into prominence a variation of velocity with wave-length, has recently repeated his experiments with special reference to the point in question, and has arrived at the conclusion that no variation exists, comparable with that asserted by Young and Forbes. The actual velocity differs little

from that found from his first series of experiments, and may be taken to be 299,800 kilometres per second.

It is remarkable how many of the playthings of our childhood give rise to questions of the deepest scientific interest. In spite of the admirable investigations of Plateau, it still remains a mystery why soapy water stands almost alone among fluids as a material for bubbles. The beautiful development of color was long ago ascribed to the interference of light, called into play by the gradual thinning of the film. Some of the phenomena are, however, so curious as to have led excellent observers like Brewster to reject the theory of thin plates, and to assume the secretion of various kinds of coloring-matter.

When the thickness of a film falls below a small fraction of the length of a wave of light, the color disappears, and is replaced by an intense blackness. Professors Reinold and Rücker have recently made the remarkable observation, that the whole of the black region, soon after its formation, is of uniform thickness, the passage from the black to the colored portions being exceedingly abrupt. By two independent methods, they have determined the thickness of the black film to lie between seven and fourteen millionths of a millimetre; so that the thinnest films correspond to about one-seventieth of a wave-length of light. The importance of these results in regard to molecular theory is too obvious to be insisted upon.

In theoretical acoustics, progress has been steadily maintained, and many phenomena which were obscure twenty or thirty years ago, have since received adequate explanation. If some important practical questions remain unsolved, one reason is that they have not yet been definitely stated. Almost every thing in connection with the ordinary use of our senses presents peculiar difficulties to scientific investigation. Some kinds of information with regard to their surroundings are of such paramount importance to successive generations of living beings, that they have learned to interpret indications, which, from a physical point of view, are of the slenderest character. Every day we are in the habit of recognizing, without much difficulty, the quarter from which a sound proceeds; but by what steps we attain that end has not yet been satisfactorily explained. It has been proved, that, when proper precautions are taken, we are unable to distinguish whether a pure tone (as from a vibrating tuning-fork held over a suitable resonator) comes to us from in front, or from behind. This is what might have been expected from an *a priori* point of view; but what would not have been expected is, that with almost any other sort of sound, from a clap of the hands to the clearest vowel-sound, the discrimination is not only possible, but easy and instinctive. In these cases it does not appear how the possession of two ears helps us, though there is some evidence that it does; and, even when sounds come to us from the right or left, the explanation of the ready discrimination which is then possible with pure tones is not so easy as might at first appear. We should be inclined to think that the sound was heard much more loudly with the ear that is turned towards than with the ear that is turned from it, and that in this way the direction was recognized. But, if we try the experiment, we find, that, at any rate with notes near the middle of the musical scale, the difference of loudness is by no means so very great. The wave-lengths of such notes are long enough, in relation to the dimensions of the head, to forbid the formation of any thing like a sound-shadow, in which the averted ear might be sheltered.

In concluding this imperfect survey of recent progress in physics, Lord Rayleigh said emphatically that much of great importance had been passed over altogether. He should have liked to speak of those far-reaching speculations, especially associated with the name of Maxwell, in which light is regarded as a disturbance in an electro-magnetic medium. Indeed, at one time, he had thought of taking the scientific work of Maxwell as the principal theme of his address. But, like most men of genius, Maxwell delighted in questions too obscure and difficult for hasty treatment; and thus, much of his work could hardly be considered upon such an occasion as the present. Maxwell's endeavor was always to keep the facts in the foreground; and to his influence, in conjunction with that of Thomson and Helmholtz, is largely due that elimination of unnecessary hypothesis which is one of the distinguishing characteristics of the science of the present day.

In speaking unfavorably of superfluous hypothesis, Lord Rayleigh did not wish to be misunderstood. Science is nothing without generalizations. Detached and ill-assorted facts are only raw material, and, in the absence of a theoretical solvent, have but little nutritive value. At the present time, and in some departments, the accumulation of material is so rapid that there is danger of indigestion. By a fiction as remarkable as any to be found in law, what has once been published, even though it be in the Russian language, is usually spoken of as 'known;' and it is often forgotten that the rediscovery in the library may be a more difficult and uncertain process than the first discovery in the laboratory. In this matter, we are greatly dependent upon annual reports and abstracts, issued principally in Germany, without which the search for the discoveries of a little-known author would be well-nigh hopeless. Much useful work has been done in this direction in connection with our association. Such critical reports as those upon hydro-dynamics, upon tides, and upon spectroscopy, guide the investigator to the points most requiring attention, and, in discussing past achievements, contribute in no small degree to future progress. But, though good work has been done, much yet remains to do.

In estimating the present position and prospects of experimental science, there is good ground for encouragement. The multiplication of laboratories gives to the younger generation opportunities such as have never existed before, and which excite the envy of those who have had to learn in middle life much that now forms part of an undergraduate course. As to the management of such institutions,

there is room for a healthy difference of opinion. For many kinds of original work, especially in connection with accurate measurement, there is need of expensive apparatus; and it is often difficult to persuade a student to do his best with imperfect appliances, when he knows that by other means a better result could be attained with greater facility. Nevertheless, it seems important to discourage too great reliance upon the instrument-maker. Much of the best original work has been done with the homeliest appliances; and the endeavor to turn to the best account the means that may be at hand develops ingenuity and resource more than the most elaborate determinations with ready-made instruments. There is danger, otherwise, that the experimental education of a plodding student should be too mechanical and artificial, so that he is puzzled by small changes of apparatus, much as many school-boys are puzzled by a transposition of the letters in a diagram of Euclid.

In closing, Lord Rayleigh touched on the 'Greek question,' or 'Greek and Latin question,' and tried to ease the fears of the good souls who fear some day to awake and find their souls are no longer their own, but have been made away with by some scientific investigator.

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

U. S. geological survey.

(Work proposed for the ensuing fiscal year.)

THE plans for work to be done during the year ending June 30, 1885, have been matured as follows, subject to the exigencies of the service:—

North Atlantic district. Topography.—The work done during the past year, in this district, by the authority of the secretary of the interior, will be continued under the general direction of Mr. Henry Gannett. Recognizing the value of the work in progress in Massachusetts, the governor recommended and the legislature appropriated a sum of forty thousand dollars, to be expended during three years—ten thousand the first year, and fifteen thousand during two succeeding years—for topographic work, to be done under the general direction of a commission appointed to co-operate with the geological survey. This commission consists of Hon. F. A. Walker, president of the Institute of technology, Prof. N. S. Shaler of Harvard college, and Assistant H. L. Whiting of the coast-survey. Four parties will be put in the field, in charge of Messrs. H. F. Walling, Anton Karl, J. D. Hoffman, and S. H. Bodfish respectively, assisted by Mr. W. G. Newman and others. The topographic work by the state of New Jersey having ceased, and the material having been transferred to the geological survey without expense to the United States, it is proposed that the topographical work be taken up by Mr. C. C. Vermeule, aided by competent assistants, under the general superintendence of Prof. George H. Cook, state geologist, who gives his services gratuitously for that purpose.

General geology.—General geological work will be carried on in New England under the direction of Prof. R. Pumpelly.

South Atlantic district. Topography.—The work begun in 1882 will be continued under the general direction of Mr. Gilbert Thompson. Six topographical parties will enter the field under Messrs. C. M. Yeates, Morris Bien, F. M. Pearson, W. A. Shumway, and one other; there will be also two triangulation parties, one under S. S. Gannett, with general assistants Messrs. Wilson, Blair, McKinney, Oyster, Hackett, Hayes, Wakefield, Niblack, Michler, and Harrison. The area it is proposed to survey includes that portion of the Appalachian region comprised in eastern Kentucky, south-western Virginia, western North Carolina, eastern Tennessee, north-western South Carolina and Georgia, and northern Alabama.

General geology.—This part of the work in this district will be in charge of Mr. G. K. Gilbert, assisted by Messrs. I. C. Russell, Ira Sayles, H. R. Geiger, J. C. White, and W. D. Johnson. The work begun in the District of Columbia will be suspended during the absence of parties in the field, but the geology will be extended by Mr. McGee through parts of Virginia and Maryland.

Southern Mississippi and Rocky Mountain district. Topography.—Excepting in Yellowstone National Park, the general direction of work in this district will be taken by A. H. Thompson. In Arizona two parties, under H. M. Wilson and A. P. Davis, will be assisted by Messrs. Holman, Wallace, Maher, and Chapman. In Texas, Mr. E. M. Douglas will direct the work, as will Mr. R. U. Goode, with Messrs. Hawkins and Ratcliff assisting, in parts of Kansas, Missouri, and Arkansas. Some astronomical work in this district will be executed by Mr. Robert S. Woodward, assisted by Bushrod Washington. In the Yellowstone National Park, Mr. J. H. Renshawe will remain in charge of the work, assisted by Ensigns Chase and Garrett and Mr. S. A. Aplin.

Geology.—Arnold Hague, assisted by Messrs. Iddings, Weed, Wright, and Davis, will carry on the geological survey of the Yellowstone Park.

Northern Mississippi and Rocky Mountain district. Geology.—The survey of the glacial formations in this district will be continued under Prof. T. C. Chamberlin, assisted by Messrs. Salisbury and Todd. General geological work in Michigan, Wisconsin, and Minnesota, will be continued, as heretofore, under the direction of Mr. R. D. Irving, assisted by Messrs. Chauvenet, Daniells, C. W. Hall, Vanhise, and Merriam. Dr. F. V. Hayden will re-enter upon his investigations of the geology of the Upper Missouri, assisted

by Dr. A. C. Peale. The extinct volcanoes of the Rocky Mountain and Cascade ranges will form the subject of continued study by Capt. C. E. Dutton, U.S.A., assisted by Messrs. Diller and Van Hoesen.

Economic geology. — The commissioner of Indian affairs having requested, and the secretary of the interior having directed it, an examination of the coal-lands of the Great Sioux reservation in Dakota will be made by Mr. Bailey Willis and assistants. In Colorado, especially in the Kokomo, Silver Cliff, and Denver districts, work will be continued by Mr. S. F. Emmons, assisted by Messrs. Cross, Dun, Eakins, Hillebrand, Rodgers, and Schonfarber.

District of the Pacific. Topography. — This work, which has been in progress for two years, will be in charge of Mark B. Kerr, assisted by Messrs. Ricksecker and Ahern. The topographical and geological survey, carried on under the auspices of the Northern Pacific railway in Montana and Washington Territory by Prof. R. Pumpelly, having been discontinued, the maps, field-notes, and material have, at his instance, been turned over to the U. S. geological survey. These explorations, covering some forty-two thousand square miles, will thus be utilized and made public on the standard scale of the survey.

Geology. — Dr. Becker, assisted by Messrs. Melville, Raborg, and Turner, will continue the geological exploration of the cinnabar deposits of California.

(General work of the survey.)

Statistics and economic geology. — Last year Mr. Albert Williams, jun., collected a large amount of mining statistics, which were issued under the title of the 'Mineral resources of the United States.' No volume published by the survey has been more eagerly sought for, or given more general satisfaction. It is proposed to issue one of these volumes yearly, thus bringing the mining statistics annually up to date.

Paleontology. Vertebrates. — The vertebrate paleontology of the north-west will be further investigated by Prof. O. C. Marsh, assisted by Messrs. Williston, Bostwick, Hermann, and Barbour. Invertebrates. — Dr. C. A. White, assisted by Messrs. J. B. Marcou, L. C. Johnson, and Frank Burns, will carry on investigations among mesozoic and tertiary forms. Mr. C. D. Walcott, with the assistance of Messrs. Cooper Curtice and J. W. Gentry, will investigate the paleozoic fauna. The work on the fossil lamellibranchiata, begun by Professor James Hall, will be promoted by the assistance of the survey. Paleobotany. — Dr. Newberry will continue his work on the fossil flora of the north-west, and Prof. W. M. Fontaine his researches on mesozoic botany; while general paleobotany will be in charge of Mr. Lester F. Ward, assisted by Mr. O. C. Ward.

Chemistry. — Since the organization of the laboratory of the survey, its work has grown enormously, almost precluding original investigations by the mass of economic questions demanding solution. The work will continue to be directed by Prof. F. W. Clarke, assisted by Messrs. Chatard, Gooch, Barns, Hallock, Manners, Whitfield, Erni, Chase, and Howard.

Forestry. — The work of mapping the forest districts of the United States will be continued under the direction of Mr. George W. Shutt.

Publications. — Mr. W. H. Holmes will continue to supervise the preparation of the illustrations of various kinds for the survey publications, on the satisfactory and artistic character of which so much depends. He will be assisted by qualified collaborators.

RECENT PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Academy of natural sciences, Philadelphia.

July 15. — Mr. Thomas Meehan remarked that in many composite flowers the pollen is ejected from the apex of the staminal tube, and it became a matter of interest to ascertain the mechanism by which this is accomplished. The flowers of Compositae are much frequented by pollen-collecting insects, honey-gatherers seldom resorting to them. It is difficult, therefore, to watch the flow of pollen in the open air, as it is collected by the insects as fast as it appears. Some flowers of Helianthus lenticularis Dougl. were gathered, and, for the purpose of study, placed in saucers of water in a room where insects could not disturb them. In this way it was observed, that, after the corolla tube had reached its full length, very early the following morning the staminal tube commenced to grow beyond the mouth of the corolla, and by about nine A.M. had extended to a distance of one-fourth the whole length of the latter. The pollen then commenced to emerge through the upper portion of the staminal tube, which, the stamens narrowing, left the apices free. During the day the pollen continued to pour out, until by nightfall a large amount had accumulated at the apex of the tube. The morning of the second day the arms of the pistil emerged, and commenced to expand; and at once the staminal tube commenced to descend. At the end of the third day the staminal tube had retired entirely within the tube of the corolla, and, with the pistil, had begun to wither. A careful examination shows, that, through the whole course, the column of united anthers remains entirely of the same length, the filaments only being elastic. These stretch fully one-half their length. They are attached to the tube of the corolla at the inflated portion, a short distance above the akene, and extend to about midway between this point and the end of the tubular portion at the base of the limb; but, when the anther-tube is extended, the filaments occupy the whole of the space. Thus pollen could fall on the stigma of the previous day's flower; but, as this is

already covered by its own, such a supply is hardly likely to be of much service: we may therefore say that the arrangements favor self-fertilization.

Philosophical society, Washington.

May 24. — Mr. H. H. Bates read a paper on the physical basis of phenomena. —— Professor Thomas Robinson spoke of the strata and timbering of the east shaft of the water-works extension. As an incident to the engineering-works for the increase of the water-supply of Washington, a shaft has been sunk through the superficial deposits in the vicinity of Howard university. Professor Robinson presented a complete record of the formations pierced by the shaft, and discussed, also, the peculiar method of timbering.

June 7. — Mr. G. K. Gilbert presented a plan for the subject-bibliography of North-American geologic literature; and Major J. W. Powell presented a slightly different plan for the same purpose. These plans proposed to establish at the outset a limited number of divisions of the subject-matter of the literature, and to simultaneously prepare a bibliography of each, the total number of bibliographies being about seventy-five. A long discussion ensued, in the course of which the plans were vigorously criticised by Dr. Billings, who maintained that any classification would be found to require continual modification, and would be ultimately unsatisfactory. He advocated the adoption of the subject-index method, and the accumulation of a large body of references before classification was attempted.

NOTES AND NEWS.

WE have much pleasure in presenting the readers of *Science* with a few facts relating to some of the more prominent members of the British association, who are expected to be present at the Montreal meeting.

The permanent general secretaries (honorary) are Capt. Douglas Galton and Mr. A. G. Vernon Harcourt. The former has held office for many years; and, in addition to a wide scientific culture, possesses a special knowledge of every thing relating to sanitary science, and hence has been much engaged in promoting the International health exhibition. He is a cousin of Mr. Francis Galton. Mr. Harcourt is a near relative of the home secretary of state, and is professor of chemistry at Christchurch college, Oxford. He has devoted special attention to the chemistry of gas-lighting. The secretary, and general executive officer of the association, is Prof. T. G. Bonney, who is now president of the Geological society of London. For many years he was fellow and tutor of St. John's college, Cambridge, but at present fills the chair of geology, etc., at University college, London. He is distinguished rather as a petrologist and mineralogist than as a paleontologist. The treasurer, Prof. A. W. Williamson, the distinguished chemist, is unable to attend this meeting; but his functions will be discharged by Professor Burdon Sanderson, Waynflete professor of physiology at Oxford, and one of the scientific advisers of the government. The president of the association for this year is the Right Hon. Lord Rayleigh, an account of whose life is given on another page.

Among the twelve vice-presidents are the Right Hon. Sir Lyon Playfair, Sir J. D. Hooker, and Prof. E. Frankland. Sir L. Playfair has been nominated as the president of the association for the Aberdeen meeting in 1885. Born in 1819, he very early took great interest in chemistry, and in 1858 was elected professor thereof in the University of Edinburgh, which he now represents in parliament. He rendered great services as special commissioner in charge of juries at the International exhibitions of 1851 and 1862. In 1873–74 he was postmaster-general, and from 1880 to 1883 was deputy-speaker of the house of commons, and chairman of committee of ways and means. A great authority on all educational questions, he is one of the very few members of parliament who are eminent in science. Sir J. Hooker, the director of Kew gardens, so famous for his investigations of the laws which govern plant-distribution, was president of the Royal society from 1873 to 1878, and of this association in 1868. In 1877 he accompanied the U.S. survey parties in Utah and Colorado. Dr. Frankland, born in 1825, was president of the Chemical society in 1871, and for many years has been connected with the government teaching of chemistry, his present office being that of professor of chemistry in the Normal school of science, South Kensington. Much of his work has been in connection with the Rivers' pollution commission.

Coming now to the presidents of sections, mathematics and physics (section A) will be under the guidance of Sir W. Thomson, who has been professor of mathematics in the University of Glasgow since 1846, at which time he was twenty-two years of age. His famous researches in thermo-dynamics and in magnetism, and his practical work in submarine telegraphy, scarcely need a reference here. He was knighted in 1866, on the successful completion of the Atlantic cable, and was president of the association in 1871. Chemistry (section B) will be presided over by Prof. H. E. Roscoe, who, since 1858, has been professor of chemistry in Owens college, Manchester. He is president of the Literary and philosophical society of Manchester, and vice-chancellor of the new Victoria university. He is also one of the Royal commission on technical instruction, and will be knighted for his services in that capacity. He was president of the Chemical society in 1880, and the first president of the new Society of chemical industry in 1881. Geology (section C) will have for its president Mr. W. T. Blanford, the secretary of the Geological society of London. Section D (biology) will be guided by Prof. H. N. Moseley, who made his scientific reputation as one of the naturalists of the Challenger deep-sea surveying expedition, and eventually succeeded Professor Rolleston in his chair at the University of Oxford. Gen. Sir Henry Lefroy, a distinguished scientific officer of the Royal artillery, will preside over section E (geography). He has recently pub-

lished a valuable contribution to terrestrial magnetism. Section F (economic science and statistics) will be presided over by Sir Richard Temple, who was superintendent of relief operations for the Bengal famine in 1874, and governor of the Bombay presidency from 1877 to 1880. The president of section G (engineering) will be Sir Frederick Bramwell, brother of Baron Bramwell, the distinguished judge. He is a member of the heavy ordnance committee, and is constantly consulted by the government on engineering questions. At this meeting, the science of anthropology, instead of being, as heretofore, a sub-section of D (biology), will be raised to the dignity of a section by itself; and over section H, Dr. E. B. Tylor, the famous anthropologist, will preside. Born in 1832, he has devoted his life to the study of the races of mankind, their history, languages, and civilization. He is president of the Anthropological society, and keeper of the Oxford university museum, succeeding there Prof. H. J. Smith, whose chair of mathematics has just been filled by Professor Sylvester.

Two evening lectures to the whole association will be given on Friday, Aug. 29, and Monday, Sept. 1, by Prof. O. J. Lodge and Rev. W. H. Dallinger. Dr. Lodge is professor of physics at University college, Liverpool, and is one of the most rising physicists of the day. The subject of his discourse is 'Dust,' to which he has devoted much attention of late. Rev. W. H. Dallinger is principal of the Wesley college, Sheffield, and one of the lecturers for the Gilchrist educational trust. His subject, on this occasion, is "The modern microscope in relation to the least and lowest forms of life," his researches on which, in connection with Dr. Drysdale of Liverpool, required enormous patience and perseverance to carry to a successful issue.

Within the limits of space allotted for this purpose, a few more names of those who are expected to be present, and to take part in the meeting, may be mentioned in alphabetical order: Prof. J. C. Adams, the Lowndean professor of astronomy in the University of Cambridge, widely known as the discoverer of the planet Neptune, from calculations of disturbances in the orbits of the other planets; Professor James Dewar, Jacksonian professor of natural and experimental philosophy at Cambridge, and Fullerian professor of chemistry at the Royal institution, London (the appointment held by Faraday), whose *collaborateurs* are Professors Liveing and McKendrick; Sir F. Evans, who succeeded Admiral Richards as the hydrographer to the British admiralty; Mr. James Glaisher, the veteran aeronaut and meteorologist, who in 1865 succeeded Admiral Fitzroy in the meteorological department of the board of trade; Professor Leone Levi, born in Italy, naturalized in England in 1847, who was the main promoter of the first (Liverpool) chamber of commerce in Britain, founded in 1849 — he is a great authority on international and commercial law; Dr. W. H. Perkin, president of the Chemical society of London, and also of the Society of chemical industry, who was the founder of the aniline-dye industry, and is now engaged in magneto-optical researches; Rev. S. J. Perry, director of Stonyhurst observatory since 1860, chief of the Kerguelen Island transit of Venus expedition of 1874, and of the Madagascar similar expedition of 1882; Prof. W. Chandler Roberts, chemist to the mint, and professor of metallurgy, etc., at the normal school of science, succeeding Dr. Percy — his researches on the physical properties of alloys are well known; Dr. P. L. Sclater, one of the secretaries of this association from 1877 to 1882, who since 1859 has been secretary of the Zoölogical society of London — he is specially known as an ornithologist; and Mr. Walter Weldon, who occupies a distinguished place among those who have striven to apply pure science to manufacturing problems, chiefly connected with the soda industry, with which, probably, no man is better acquainted — he preceded Dr. Perkin as president of the Society of chemical industry.

— A number of papers and abstracts have already been received for the mechanical section (D) of the American association; and a sufficient number, in addition, are expected from prominent gentlemen, to make sure that the sessions will be of unusual interest. In addition to the address of President R. H. Thurston, two papers have been promised by Prof. William A. Rodgers of Cambridge, in connection with his already celebrated labors on standard bars, perfect screws, etc. In the same connection, a paper will be read by J. A. Brashear of Pittsburgh, Penn., on the manipulation of optical surfaces. Other papers on connected subjects are expected; and it is suggested that at least one session be devoted to these papers, and discussions upon them. From Mr. Allan Stirling of New-York City, is promised 'The economy of the electric light;' and the engineer, Mr. W. A. Traill, of Portrush, Ireland, will explain the Giant's Causeway and Portrush electric tramway, and exhibit a working model of the same. A session may therefore be occupied with modern applications of electricity. Another session will be occupied with papers upon civil-engineering subjects, among which may be mentioned, "Three problems in river physics: 1°. The transportation of sediment, and the formation and removal of sand-bars; 2°. The flow of water in natural channels; 3°. The relation of levees to the low-water navigation of rivers;" by Professor Johnson of Washington university, St. Louis, Mo. Other papers announced are, 'The strength of cast-iron,' by J. A. Millar, secretary of the Institute of engineers and ship-builders, in Scotland; 'Driven wells,' by J. C. Hoadley of Boston; 'Belting,' by Professor Lanza of the Massachusetts institute of technology; 'Steam-cylinder condensation,' by Assistant-Professor Fisher; and 'Methods of teaching in mechanical engineering,' by Professor Alden of the Worcester free institute. It is hoped that there will be sufficient papers upon the last subject to devote a session thereto, and gentlemen interested are requested to come prepared to take active part in the discussions.

Professor Webb, the secretary of the section, may in future be addressed at the association headquarters in Philadelphia; and he requests that abstracts, and especially titles of papers, should be sent as soon as

possible to the permanent secretary, Prof. F. W. Putnam, Hotel Lafayette. Space has been provided for models and apparatus, and attention is directed to the reduced rates of transportation to and from Philadelphia.

— From the report of Lieut. W. P. Ray, U.S.N., in charge of branch hydrographic office, New Orleans, La., Aug. 9, we learn that Capt. C. W. Reed, of the City of Dallas, reports that all the captains cruising along the eastern edge of the bank of Yucatan and north-eastern part of Yucatan have been very much surprised at the absence of the usual northerly current during April, May, June, and July. There has been no perceptible current until the last three days. The sailing directions give one and a half to two and a half knots per hour for these months.

— The Navy department has ordered Commander W. T. Sampson and Lieut. Commander T. F. Jewell to Montreal, in attendance on the British association for the advancement of science, and Lieut. Commander Jewell to Philadelphia during the meeting of the American association.

— The U. S. geological survey has recently published two topographical sheets of north-eastern Arizona, and one of north-western New Mexico, crossed by the line of the Atlantic and Pacific railroad, — the work of surveys in 1881, 1882, and 1883, by Messrs. Gilbert Thompson, A. H. Thompson, and their subordinates. The scale is 1: 250,000, with contours every two hundred feet. The region included is of relatively simple plateau structure, complicated by volcanic action that has built cones and spread out lava-beds, and by the erosion of irregularly branching cañons which in several places have a remarkable resemblance to the veins of a maple-leaf. Most of the stream-courses are now dry, and serve as well-enclosed trails between the scattered settlements. Shallow lakes and pools are not uncommon, and springs are marked at the heads of small ravines; but their waters soon disappear in the sand below. Many Indian villages and ruins are mapped, including the Zuni towns on the Mesas, and the cliff dwellings of the Cañons de Chelly and del Muerto. The lettering is not so good as it should be, that of the legend of the plates being about as bad as possible, and the spelling of some of the Spanish names is certainly un-Spanish. The artistic execution reflects no credit upon the survey, being far below the standard gained in recent years.

— The thirty-ninth volume of the Mémoires of the topographic section of the Russian general staff has recently appeared in St. Petersburg. Its contents comprise, among other important papers, a report by Lebedeff on the Bessarabian triangulation. As the author's work is connected with the general triangulation of the empire, it has been taken in hand with the view, among other things, of calculating the difference of level between the Black and Baltic Seas. The result, however, is subject to too large a probable error to have more than an experimental interest; but a levelling recently executed has proved that there is no sensible difference of level between the Black Sea at Odessa and the Baltic at Libava.

A topographical exploration of northern Khorassan and southern Turcomania, with the astronomical data furnished by Gladysheff, has permitted the construction of an excellent map of this region on a scale of 1: 210,000. Farther to the east, Arkhipoff has established the course of the routes leading from Karchi and Bukhara to Kilif and Charjui, along the Amu Daria.

The topography of the country between the Altai Mountains and the valley of the Upper Irtish, along the Russo-Chinese frontier, has been recently the subject of extensive exploration, a sound basis being afforded for the work by the astronomical observations of Miroshnichenko.

Triangulation has recently been carried on between Vladivostok and the Amur on a line between the Ussuri River and the west flanks of the Sikhota Mountains. In the same province, by surveys along the Russo-Chinese frontier, a termination has been put to the uncertainty in regard to the boundary which has so long interfered with the proper administration of justice and collection of taxes.

— Great preparations are being made for the exhibition of goldsmiths' work, to be held next year in the ancient town of Nuremberg. Exhibits are to be duty free; and a lottery, of which the prizes will be exhibits, will be held, and a guaranty fund of fifty thousand pounds has been subscribed. Indian and Persian work is expected; Japanese, promised. America, Spain, and Portugal have shown their sympathy with the undertaking; and France, Italy, Belgium, and Austria are already represented. The historical department is expected to be of considerable scientific interest.

— Letters received from Prjevalski announce his arrival at Alashan in January, 1884, after having crossed Mongolia without accident. No one was ill, though the mercury had frozen several times during the journey. At present the explorers should be in Thibet, or at least in Tzaïdam.

— The principal results of the meteorological station in Novaia Zemlia have been made public. The coldest monthly mean was that of January, 1883 (about $-2°$ F.); but the thermometer indicated $-61°$ F. on several occasions. The north-east and north-west winds were extremely violent, and being always accompanied by drifting snow, and sudden in springing up, were dangerous for any of the party who might be away from the station.

— The fall of a meteor near Odessa was recently reported to the French academy. It seems, that as the track of the meteor, as seen from the city, made it probable that it must have fallen near by, a reward was offered by one of the local papers for its discovery, which was responded to by a peasant who had seen it fall in the field where he was at work. It proved to be a shapeless mass of about eighteen pounds.